NAV 5216/144A (Rev. 8-81)
S/N 0107-LF-052-2320

DEPARTMENT OF THE NAVY

Memorandum

DATE: 17 Nov 1983

FROM: Environmental Engineer

TO: AC/S, Facilities

SUBJ: New River Water Quality; UNC-W Report of

Encl: (1) Bacteriological Analysis of the New River Estuary, Univ of N.C., Wilmington, 30 Apr\82
(2) NREAD Quality Control Lab Memo 21 Jul 83

1. The data in the report (enclosure (1)) does not verify the conclusion that MCB is causing pollution because:

a. Every water sample collected from creeks draining MCB also contains run-off from unsewered areas off-base (Southwest, Vernona, Dixon, and Piney Green), except for French's Creek.

b. There are no discharges from MCB of human fecal wastes to Wallace or French's Creeks from either sewers or field training sites.

c. The report contains an unresolved contradiction as to the source of the bacteria; i.e., human or animal.

d. No quality control by State or Federal water quality labs was used; in fact, the data (enclosure (2)) from the NREAD laboratory's surveys (13 times during the same period) showed significantly lower results in every sample.

2. The report's recommendation to Onslow County for a diffuser pipe from Montford Point is not addressed elswhere in the report.

3. MCB data supports the conclusion that run-off in the Jacksonville/ Northeast Creek area has the highest levels of bacteria. This study should not have implicated that animal waste or MCB run-off as the problem, but should have concluded that septic fields were the scurce of the bacteria.

Very respectfully,

A

R. E. ALEXANDER

Copy to:
NREAD (w/o encl)

Revised New River study contradicts original report

By CLINT SCHEMMER
Daily News Staff

A university scientist has revised a pollution study of the New River, contradicting the orginal report's finding that Wilson Bay — the site of Jacksonville's sewage-treatment plant — may be a public health hazard and should be closed to swimming, fishing and boating.

Ronald Sizemore, an aquatic microbiologist with the University of North Carolina at Wilmington, deleted the recommendation after reworking data collected in 1982 by UNCW researchers Gilbert Bane and Catherine Roznowski.

The conclusion Bane drew from studying water samples from Wilson Bay was flawed because his statistical method let a few high readings skew the average counts of harmful bacteria in the river, Sizemore indicated in an interview Tuesday.

"A lot of the problem with his analysis was that he used an arithmetic mean — an average to the layman," the assistant professor said. "The bacteriological standards recommend a logarithmic or geometric mean.

"When I used the geometric mean on the Wilson Bay data, it looked like it fell well within the state standards," Sizemore recounted. "So I dropped the recommendation, based on my different approach to averaging his raw data."

Bane's report cited the waters of Wilson Bay as a suspected health hazard that could infect people with viruses and bacteria carrying polio, hepatitus and other diseases.

According to Bane, the danger was that bacteria-laden sediment on the bottom of the bay, which has sluggish circulation, are being stirred by boats and discharges from the city treatment plant.

But Sizemore said water samples near the plant showed relatively low coliform bacteria readings, although other bays and tributaries along the river were definitely polluted.

"The samples right at the Jacksonville sewage treatment plant looked pretty good," he said. "But when they sampled right smack at the old bridge the data showed the highest fecal coliform count we got in the whole study. The city of Jacksonville looked like a real source of fecal pollution."

As is common in many cities, sewers from older buildings may not have been properly connected to the Jacksonville's central sewer system and untreated waste could be seeping into the river, Sizemore theorized.

Rainwater pouring over open ground and the many downtown parking lots fringing the river could also contribute to the high bacteria counts found near the bridge, he said.

Sizemore agreed with Bane's conclusion that Northeast Creek and French's Creeks are significantly polluted and added Camp Lejeune's Wallace Creek, Southwest Creek and the western portion of Stones Bay to that list.

"Those areas probably are worth looking into and finding out what the problem is," the scientist said. "I personally wouldn't like to eat shellfish from them. A fishermen doesn't like to hear that, but as a consumer, I do."

The western side of Stones Bay, which lies next to a sewage outfall from the Dixon rifle range, is the only area of the bay closed to shellfishing, a spokesman for the state Shellfish Sanitation Office in Morehead City said today.

A few miles north, above Gray Point, the entire river is closed to shellfishing and has been since at least 1965, the spokesman said.

In his revision, Sizemore writes that Wallace Creek and the Jacksonville area of the river have clearly suffered the most from fecal pollution, attributing the problem to human waste. However, other bacteriological data did not support that conclusion and instead pointed to animal feces as the source, he noted.

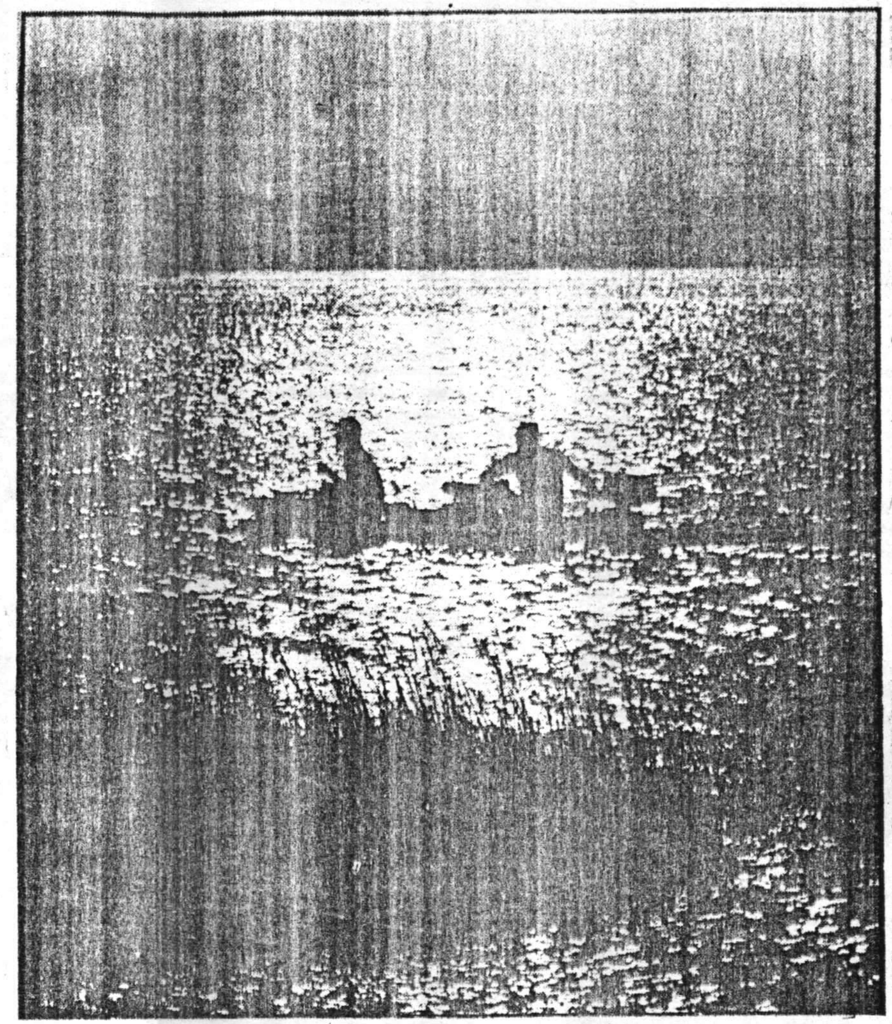
The contradiction cannot be resolved without additional study, Sizemore concluded.

Speaking by telephone from his office on the UNCW campus, Sizemore said he was surprised to find the river as clean as Bane and Roznowski's research indicates.

"I can't say it's free from pollution but reanalyzing the data, I think the majority of the river was in better shape than I had expected," he said.

"The middle of the bays were acceptable by most standards for shellfish, fishing and swimming but the creeks feeding into the river, particularly those coming from Camp Lejeune, were mildly polluted," the bacterioligist said.

Sizemore reanalyzed Bane's data at the request of Onslow County Planning Director Ken Windley, who was critical of inconsistencies in the original report, as were officials with the state Shellfish Sanitation Office and N.C. Office of Coastal Management.



Staff photo by Clint Schemmer

Boaters enjoy New River afternoon

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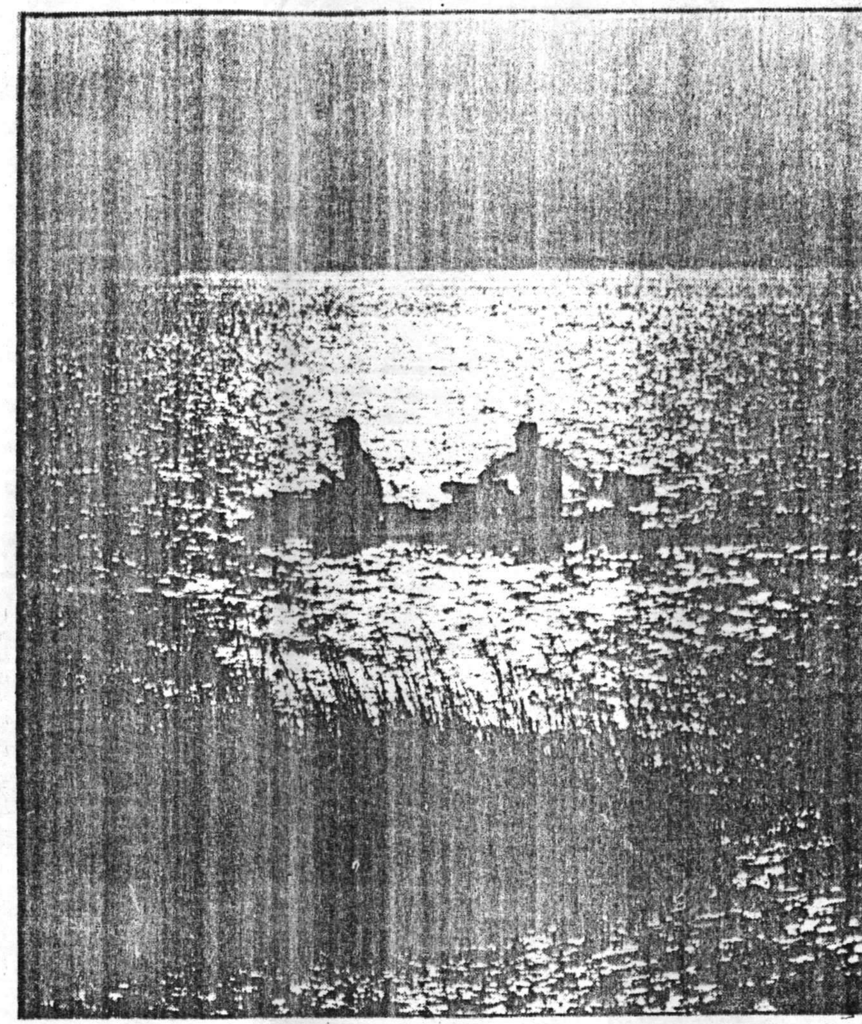

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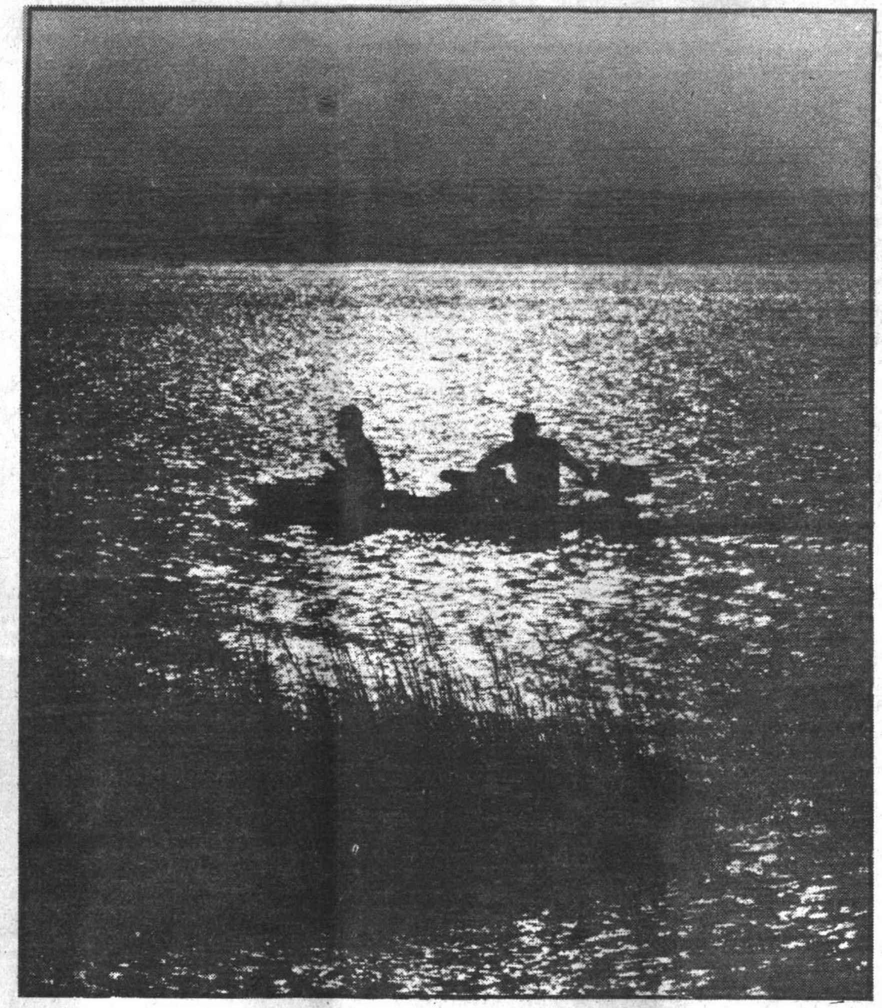

Staff photo by Clint Schemmer

Boaters enjoy New River afternoon

Junior Pants by CHEQUE[illegible]

Two styles of poly/rayon gabardine pa[illegible] that are well tailored for a perfect fit. The belted trouser is available in grey and the V-yoke style comes in black or berry. Both in sizes 5-13. Originally $28 **19.99**

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Save $6 on these button-down oxford shirts for juniors with pointed collars, patch pocket & 2-button barrel cuffs. Available in sizes 5-13; white, lilac, pink, blue or yellow. Originally $17 **10.99**

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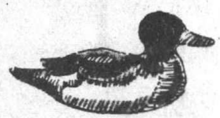

Peebles introduces a classic new collection of updated sportswear for the missy lady.

Each item features an attractive five-colored embroidered decoy duck. All for you, Now On Sale at Peebles.

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Pleated trouser & trouser skirt available in navy, khaki & grape; oxford shirt available in white, navy & kelly; stripe oxford available in navy & lilac; jersey polo available in navy; crew neck sweater available in navy & camel.

OPNAV 5216/144A (Rev. 8-81)
S/N 0107-LF-052-2320

DEPARTMENT OF THE NAVY
Memorandum

DATE: 21 July 1983

FROM: Ms. Beegs, QQuality Control Lab, Envir Br, NREAD

TO: Mr. Sharpe, Supervisory Ecologist, Envir Br, NREAD

SUBJ: Comments on the Study on the New River

ENCL: (1) Table 1. Summary of Bacteriological Data
(2) Graph 1. Coliform vs Month and Rainfall vs,Month
(3) Graph 2. Coliform vs River Location

1. The study done by UNC-W was conducted from 30 November 1980 to 7 December 1981. During this period the Quality Control Lab made 13 river runs and made 12 collections in Wallace Creek that summer.

2. The UNC-W study covered the river from the Sneads Ferry bridge on up. They divided the river into 14 areas with 7 stations. Nine areas and four stations included sample points used by the Q. C. Lab. Enclosure (1) is Table 1. Summary of Bacteriological Data from the study with the addition of the Q. C. Lab data below the related UNC-W data. The geometric meand obtained by the Q. C. Lab were lower than that in the study. This could be attributed to the differende in the methods used. The study used the Most Probable Number(MPN) m method. This method, described on page 18 of the study, takes portions of the sample and sets up 5 tubes. From an MPN table, using the dilutions and the number of positive tubes a colony count per 100 ml is obtained. The Q. C. Lab uses the Membrane Filter(MF) method, where 100 ml or dilutions afeahe sample are filtered through a filter designed to trap bacteria. The filter is then incubated and an actual colony count is obtained.

3. The study conducted the following analysis:

Salinity	Total & Fecal Caliform by MPN
Turbidity	Dissolved Oxygen
Air & Water Temperatures	Fecal Streptococci
Rainfall	Pseudomonas aeruginosa

The Q. C. Lab analyzes all river points for Total and Fecal Coliform but by MF. At the points labelled RW01-09 the Lab analized for Water Temperature and Dissolved Oxygen. Salinity is a measure of the amount of salts in a solution. Turbidity is a measure of the clarity of a sample, how cloudy or muddy it is. Dissolved Oxygen is a measure of oxygen in solution in the sample. The three microbiology parameters are discussed below.

4. Coliform is the most commonly found bacteria and in themselves are not disease producing. They are indicator organisms meaning if any pathogenic organism is present coliform will also be present in greater numbers and are therefore tested for. Fecal Coliform are found in the intestinal tract of warm blooded animals and therefore their feces. Fecal Streptococci is also present and last longer in water and are better indicators of past pollution. The main reason F. Strep is analized for is that the rationof Fecal Coliform to Fecal Streptococci varies significantly between Human and animal feces. Therefore by determining the ratio the source of pollution can also be determined. This is also true of Pseudomonas aeruginosa . P. aeruginosa is a pathogen that grows in the presence of

DEPARTMENT OF THE NAVY

Memorandum

[illegible]

Subj: [illegible] Quality Control Laboratory [illegible]

Ref: (a) [illegible]

Encl: (1) Table 1. Summary of Meteorological Data
(2) Graph 1. Coliform vs month and rainfall [illegible]
(3) Graph [illegible] Coliform [illegible] location [illegible]

1. [illegible]

2. The [illegible] survey [illegible] the [illegible] were divided [illegible] into [illegible] sections [illegible] sample points [illegible] Enclosure (1), Table 1, summary of meteorological data from the study [illegible] This could be attributed [illegible] the study [illegible] Most Probable Number (MPN) method [illegible] using the dilutions [illegible] positive tubes [illegible] the membrane filter (MF) method [illegible] filtered [illegible] filter [illegible] count is obtained.

3. The [illegible] conducted the following analyses:

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[illegible] dissolved oxygen [illegible]
[illegible] temperature [illegible] Fecal Streptococci
[illegible]

4. [illegible] analysis [illegible] for total [illegible] fecal coliform [illegible] [illegible] in a solution [illegible] [illegible]

5. [illegible] They are [illegible] [illegible] fecal coliform [illegible] [illegible] and [illegible] [illegible] pollution [illegible] determining the [illegible] [illegible]

human wastes. Therefore if the Fecal Coliform and P. aeruginosa are both high, it indicates the source to be human.

5. The only relationship found between the bacteria and the other parameters was that fo Nouwden rainfall and bacteria. High rainfalls incresed bacteria counts. This has always bhhwwshown by the Q. C. Labddaaa. Enclosure (2) is a graph of the Q. C. Lab bact data and geometric means with rainfall data for the period of the study. The graph supports the relationship.

6. The study concluded that high coliform counts are concentrated around the populated a ares. These river ares are also the narrow and shallower areas. They did point out that the colony counts decmeased going down the river. Besides a decreased population, the dilution factor, which is large due to the greater depth of the river, could attribute to th e lower concentrations downstream. Enclosure (3) is a graph of Q. C. Lab Colfform counts vs river locations. RW01 is a Hwy 17 bridge and RW06 is at the Sneads Ferry Bridge and the graph shows that concentrations decrease going down river.

7. The source of the bactefia in the lower sections of the river was determmined to be animal. No Conclusion count be made about the source in the high bacterial density areas, upper section,, The Fecal Streptococci and P. aeruginosa ratio conclusions contradicted themselves in these areas.

8. The reportedtated that sewage outfalls are probably not the primary source of coliform pollution. It listed four activitites observed that could have influenceddbacterial density which were:

1) U. S. Marine Corps Field Exercises.
2) Extensive Deer Herds.
3) Domestic Animals kn the agricultural areas.
4) Increased runoff as a result of construction..

The construction of the new NRMC was in progess during this survey, however NREAD worked with personnel ar the construction site to reduce runoff. As to field exercises, port-a-johns are least to prevent such contamination.

9. I. am in agreement with the 5 conclusions listed on pages 2 & 3 and restated on pages 42 &483 of this report. On pages 3 & 4 there are 6 recommendations...The only recommendation I am not in agreement with is the second one. It calls for a diffuser pipe for storm drainage from Montford Point into Morgan Bay. I question the real necessity of it.

Elizabeth A. Betz
Supervisory Chemist

[illegible] in the [illegible]

[illegible] and [illegible] the [illegible]

[illegible] will be [illegible] for [illegible]

[illegible] discussed [illegible]

[illegible] the [illegible]

[illegible] shown [illegible]

[illegible]

[illegible] results [illegible]

[illegible] and [illegible] as a result of [illegible]

[illegible] during [illegible]

[illegible]

ONSLOW COUNTY

Office of the
Planning Department

39 Tallman Street
Jacksonville, NC 28540
Telephone (919) 455-3661

July 8, 1983

Colonel John Marshall
U.S. Marine Corps
Assistant Chief of Staff Facilities
Camp Lejeune, NC 28542

Dear Colonel Marshall:

Enclosed is a recent report completed for Onslow County and the City of Jacksonville by UNC-Wilmington concerning levels of coliform and fecal coliform bacteria in the New River. Dr. Ronald Sizemore, who recently revised this report, indicates that, among other areas, Wallace Creek had high levels of coliform and fecal coliform bacteria. You may wish to review the enclosed document and respond if you have a problem with the results.

We look forward to reviewing your comments.

Sincerely,

Kenneth N. Windley, Jr.

Kenneth N. Windley, Jr.
Planning Director

KNWJR/mad

Enclosure

University of North Carolina
at Wilmington
28406

DEPARTMENT OF BIOLOGY
MARINE SCIENCE BUILDING 141
POST OFFICE BOX 3725

June 24, 1983

Received 6-29-83

Mr. K. Winley
Onslow County Planning Dept.
39 Tallman Street
Jacksonville, NC 28540

Dear Mr. Winley:

Enclosed is an edited copy of the Project Report submitted by Dr. Bane and Ms. Roznowski. Hopefully, most of the problems found in the original report have been eliminated.

A major difference you will find in the edited report is that the log (geometric) mean was used to express bacterial counts instead of the arithmetic (common) mean. The log mean is recommended both by the state agencies involved with water quality and by Standard Methods.

The edited report has also been shortened and, hopefully, is a little more readable.

If you have any additional questions, please feel free to contact me.

Sincerely,

Ronald K. Sizemore
Ronald K. Sizemore
Assistant Professor

RKS:lrr

Enclosure

cc: Dr. Bane
Catherine Roxnowski
James Clark

BACTERIOLOGICAL ANALYSIS OF THE NEW RIVER ESTUARY

JACKSONVILLE, NORTH CAROLINA

by

Gilbert W. Bane
Director, Environmental Studies

and

Catherine C. Roznowski
University of North Carolina at Wilmington

A Final Research Project Report
to
The Onslow County Planning Department

April 30, 1982

Edited copy submitted
June, 1983

TABLE OF CONTENTS

ABSTRACT

A one year study of the bacteriological quality of the New River Estuary, Jacksonville, North Carolina, found high coliform levels in the water of some sampling sites. These coliforms are predominantly of non-human animal origin and from non-point sources. This conclusion is based on fecal streptococci to fecal coliform ratios and Pseudomonas aeruginosa results. High fecal and total coliform counts were recorded in peripheral sites in the estuary such as headwaters of the creeks (e.g. Wallace Creek) and near the city of Jacksonville. Low fecal and total counts occur in the mid-water sites of Stones and Farnell Bays, probably as a result of high tidal fluxuation and deeper water. The total and fecal coliform counts increased with rain. Coliform pollution is of economic consequence to residents of Onslow County, since approximately 1000 people use the river on the average of once a month and most are involved in recreational fishing or boating.

SUMMARY AND RECOMMENDATIONS

During a one year study of the bacteriological quality of the New River Estuary, Jacksonville, North Carolina, the coliform levels in the water were determined. Testing was performed according to nationally accepted Standard Methods for the Examination of Water and Wastewater (American Public Health Association, 1975). The sources of these coliforms were predominantly from waters from non-point sources that were contaminated by fecal pollution from non-human animals. This conclusion was based upon fecal streptococci to fecal coliform ratios and *Pseudomonas aeruginosa* results. High fecal and total coliform counts were recorded in peripheral sites in the estuary, such as headwaters of the creeks, near the city of Jacksonville and in Wallace Creek. Low fecal and total coliform counts were observed in the mid-water sites of Stones and Farnell Bays. The counts in these sites were lower due to high tidal fluxuations, high salinity and deeper water. The total and fecal coliform counts increased directly after rainfall.

Coliform pollution is of economic importance to Onslow County residents. Approximately 1000 people, involved in recreational fishing and boating, use the river on the average of once a month.

Analysis of field and laboratory data collected during this study led to the following conclusions:

1) High total coliform and fecal coliform counts are concentrated around the populated areas of Jacksonville

[illegible] committee [illegible]

[illegible] political [illegible]

[illegible] consideration [illegible]

[illegible] point [illegible]

[illegible]

City and in Northeast Creek, Frenchs Creek and Wallace Creek.

2) Most coliform counts suggest that the coliform bacteria are from non-point sources and are attributed to run-off water from agricultural pastures, wildlife, sanitary landfills and storm drains.

3) Fecal streptococci and Pseudomonas aeruginosa data indicate that most non-point source coliform pollution is of a non-human animal origin.

4) Seasonal distribution patterns of coliform bacteria showed peaks, due to increased rainfall, in February, June and August.

5) Increased levels of coliform bacteria will be detrimental to recreational and commercial use of the New River watershed area, as with high coliform levels additional shellfish areas are likely to be closed. Decreased coliform counts tend to benefit the socio-economic growth and stability since more clean areas will be available for the recreation usage of county residents.

The following recommendations are proposed as an aid to Onslow County planning and public health services:

1) All new dwellings and businesses should be connected to city or county sewage treatment facilities. All existing septic tanks should be monitored periodically to insure conformation to existing regulation; furthermore, a thorough analysis of setback distances and related pollution is recommended.

2) A diffuser pipe to carry off storm drainage and excess runoff should be established from Montford Point running southeast 500-1000 yards into Morgan Bay. This will dilute bacteria carrying waters and will bring bacteria arising from land excess runoff in contact with higher salinity saltwater with antibacterial results. but bad for shellfish?

3) Future landfills should be isolated on soils suitable to bacterial degradation and which will not otherwise contribute to the existing bacterial levels in the bay. The existing landfill on Northeast Creek is minimally adequate, but during times of heavy rainfall this creek significantly contributes to bacteria in the estuary. coliform?

4) The surrounding watershed, consisting of barren land, should be improved through the planting of suitable ground cover, i.e. grass or trees, in order to increase the holding of water in the soil.

5) Evaluation of the capability of all existing sewage disposal and septic systems that handle wastes in the county should be initiated to reflect the needs which are anticipated as the population increases.

6) We urge that tests done on suspected pollution in the estuary use analyses appropriate to distinguish between *E. coli* and other related bacteria. Standard testing such as fecal streptococci counts and *Pseudomonas aeruginosa* counts can be used for this purpose.

INTRODUCTION

The New River Estuary, located in Onslow County, North Carolina, is bordered on the north by Jones County, Duplin County to the west, Carteret County and Onslow Bay on the east, and to the south, Pender County. Planners in Onslow County and Jacksonville are presently concerned with the water quality of the New River and its adjacent estuary because of the present and potential use of these waters for boating, swimming, commercial and recreational finfishing and shellfishing. Local sanitary engineers have suggested that the proximity of sewage disposal systems to regional estuaries, the influence of water runoff and the discharges from storm drains and other outflows have added to the bacteriological burden of the bay. Because these waters lie within the urban region dominated by the Camp Lejeune Marine Base, the City of Jacksonville and several other coastal communities, concern for water quality has risen sharply.

To assess bacteriological water quality, indicator microorganisms are routinely enumerated. Indicator organisms are associated with the intestinal tract, and their presence in water indicates that the water has received contamination of an intestinal origin. The coliform group of microorganisms are extensively used as indicators because they are common inhabitants of the intestinal tract of humans and other warm-blooded animals and are generally present in the intestinal tract in large numbers. When present in the water environment, the coliform organisms eventually decrease in number but at rates

no faster than the pathogenic bacteria, Salmonella and Shigella (Dawe & Penrose, 1978). Both the coliforms and the pathogens behave similarly during water purification processes (Brock, 1979). Therefore, because of the wide variety of microbial pathogens associated with the human intestinal tract (e.g. typhoid fever, cholera, polio, etc.) and the impracticality of enumerating all of these microorganisms, only coliform bacteria are routinely enumerated. The presence of coliforms is usually associated with the presence of fecal pollution but not necessarily with the presence of pathogenic microorganisms. However, since fecal pollution is aesthetically unacceptable and is often associated with potential human disease, coliform counts are the most widely used monitor of water quality.

The use of coliforms as indicators of fecal pollution has some technical and theoretical problems. The bacterium, E. coli, is the most common aerobic bacterium found in human feces. This bacterium presence in the water column is highly correlated with fecal pollution. Unfortunately, enumerating E. coli specifically is difficult. Therefore, simpler techniques have developed to enumerate E. coli and closely related bacteria (i.e. coliforms). In practical terms, coliform is defined by the American Public Health Association (1975) as, "bacteria that are aerobic or facultative anaerobic, gram negative, non-spore forming and rod-shaped, that ferment lactose with gas formation within 48 hours at 35°C." This definition includes E. coli; other related enteric bacteria Klebsiella, Citrobacter, Enterobacter, and non-enteric bacteria such as Aeromonas. Unfortunately, these

other coliform bacteria are found in sources other than the intestinal tract and coliform counts may occur in non-fecally polluted waters.

Thus, additional techniques have been developed to find better indicators of fecal pollution. One technique is to enumerate "fecal coliforms." By APHA definition, "fecal coliforms are those that ferment lactose with gas formation in a suitable culture medium in 24 hours at 44.5°C." This definition is limited to E. coli and some types of thermotolerant Klebsiella. Thus, this technique comes closer to counting only E. coli and has less false positive results.

Other types of indicator organisms can also be enumerated. Fecal streptococci and enterococci are normally found in the intestinal tract of man and animals and are also a useful indicator of fecal pollution. Fecal streptococci persist longer in water and are thus better indicators of past pollution. However, most valuable application of the fecal streptococci test in the determination of ratios of fecal coliform to fecal streptococci. Because coliform predominates over streptococci in human feces but not animal feces, ratios of 4.0 or higher typically indicate domestic waste while ratios of 0.6 or lower indicate discharge from farm animals or storm water runoff (American Public Health Association, 1975).

During this study, a third type of microorganism was enumerated. Pseudomonas aeruginosa is an "opportunistic" human pathogen which may multiply in recreational waters in the presence of sufficient nutrients (American Public Health

Association, 1975). Its enumeration is valuable because it may indicate the discharge of nutritive wastes into receiving waters. Cabelli and co-workers (1976) examined the relationship of P. aeruginosa levels to fecal coliform densities in estuarine and fresh recreational waters at varying distances from known pollution sources in Lake Michigan. They showed that P. aeruginosa may indicate pollution of recreational waters by human wastes, especially where the probability of bacterial multiplication is minimal. High fecal coliform densities coincident with low P. aeruginosa levels suggest that the source of fecal pollution is animal rather than human.

This report summarizes a 1980-1981 study of water quality of the New River Estuary, Jacksonville, North Carolina. Onslow County's research goals and the goals of this study were (1) to develop a system which would abate the high coliform bacterial levels which presently occur in the river and estuary; (2) to determine specific sources of coliform bacteria; and (3) to assess seasonal changes in the abundance and distribution of coliform bacteria throughout the area. This resultant information will be utilized in decision-making processes affecting recreational and commercial land use.

This study was funded by Onslow County, the City of Jacksonville and the North Carolina Department of Natural Resources and Community Development through the Office of Coastal Zone Mangement (grant number: 2984-80-0043) awarded to the University of North Carolina at Wilmington on November 10, 1980. The principle investigator was Dr. Gilbert W. Bane.

The specific objectives of the funded study were:

1) to assess the coliform distribution in the waters of the New River adjacent to the City of Jacksonville and around the shores of Camp Lejeune Marine Base;
2) to define point and non-point sources of pollution in the estuary;
3) to demonstrate seasonal and geographic changes in coliform counts in the New River Estuary as an indicator of pollution;
4) to present information on the economic consequences of coliform pollution to the residents of Onslow County;
5) to evaluate and define appropriate alternatives to the present discharge system.

The research reported in this report emphasizes objectives 1, 2 and 3. Objectives 4 and 5 were used as supplemental material to show the significance of scientific data.

METHODS AND MATERIALS

A total of 356 samples for bacteriological analysis from 65 sites were collected between November 30, 1980 and December 7, 1981. The sampling dates are listed as part of the station code numbers shown in Appendix I. The sampling areas were in the region of the New River Estuary between Stones Bay and the river north of Jacksonville (Figure 1). Sample sites, indicated on the map (Appendix I) were selected for their proximity to either permanent channel markers or automobile bridges. Seven sites designated major stations (Figure 2) were sampled at least once per month except on rare occasions when weather did not permit sampling (e.g. sampling station dry or frozen). The remaining 58 stations were sampled at least three times and are designated by station number identifier codes. Samples at major stations also had identifier codes (see Figure 2).

FIELD COLLECTION

Thirteen student workers, of which eight were funded and five received credit in Seminar in Environmental Studies, EVS 495, assisted in field and laboratory analysis. The students worked under the direct supervision of the Project Director and performed routine tasks in order to allow for increased numbers of samples to be analyzed.

Water for analysis was collected in presterilized 200 ml glass bottles. The bottles were submerged a few inches below the

FIGURE 1 - MAP SHOWING THE NEW RIVER ESTUARY SAMPLE AREAS

AREA A CONTAINS STATION NUMBER IDENTIFIER CODES 1-21

AREA B CONTAINS STATION NUMBER IDENTIFIER CODES 22-37

AREA C CONTAINS STATION NUMBER IDENTIFIER CODES 38-63

AREA D CONTAINS STATION NUMBER IDENTIFIER CODES 115-142

AREA E CONTAINS STATION NUMBER IDENTIFIER CODES 64-65

AREA F CONTAINS STATION NUMBER IDENTIFIER CODES 66-110

AREA G CONTAINS STATION NUMBER IDENTIFIER CODES 111-114, 143-159, 200-205

AREA H CONTAINS STATION NUMBER IDENTIFIER CODES 160-189

AREA I CONTAINS STATION NUMBER IDENTIFIER CODES 206-223

AREA J CONTAINS STATION NUMBER IDENTIFIER CODES 281-293

AREA K CONTAINS STATION NUMBER IDENTIFIER CODES 224-280

AREA L CONTAINS STATION NUMBER IDENTIFIER CODES 300-329, 341-355

AREA M CONTAINS STATION NUMBER IDENTIFIER CODES 294-299, 330-340

AREA N CONTAINS STATION NUMBER IDENTIFIER CODES 356-366

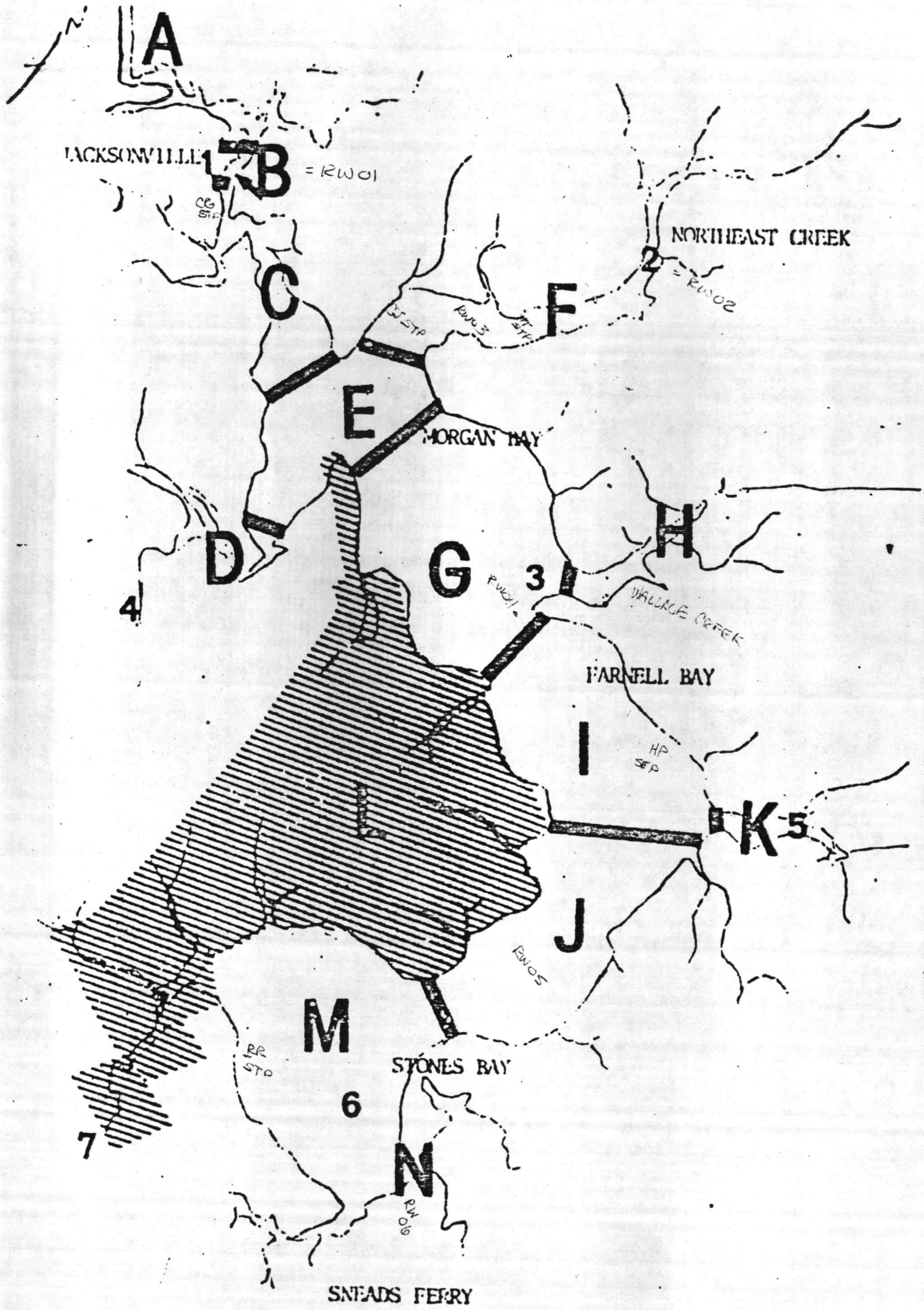

A
JACKSONVILLE
1
B
= RW01
CG STP
NORTHEAST CREEK
2
= RW02
C
F
RW03
E
MORGAN BAY
H
D
G
3
4
WALLACE CREEK
FARNELL BAY
I
HP STP
L
K
5
J
RW05
M
STONES BAY
RR STP
6
7
N
RW 06
SNEADS FERRY

FIGURE 2 - MAPS SHOWING THE SEVEN MAJOR SAMPLING STATIONS IN THE NEW RIVER ESTUARY

STATION 1 IS STATION NUMBER IDENTIFIER CODES 22-37

STATION 2 IS STATION NUMBER IDENTIFIER CODES 81-95

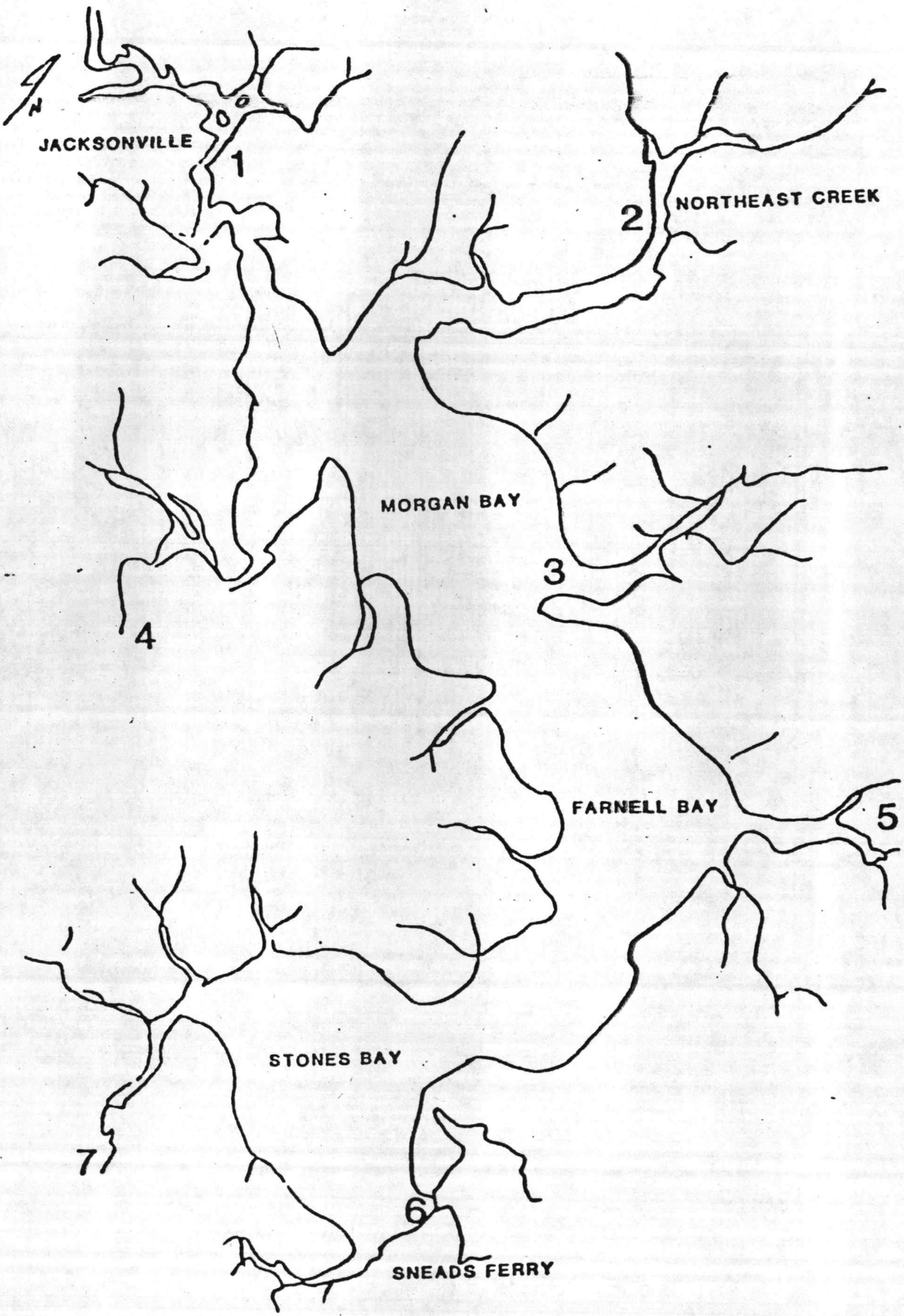
STATION 3 IS STATION NUMBER IDENTIFIER CODES 160-177

STATION 4 IS STATION NUMBER IDENTIFIER CODES 133-142

STATION 5 IS STATION NUMBER IDENTIFIER CODES 254-264

STATION 6 IS STATION NUMBER IDENTIFIER CODES 356-366

STATION 7 IS STATION NUMBER IDENTIFIER CODES 347-355

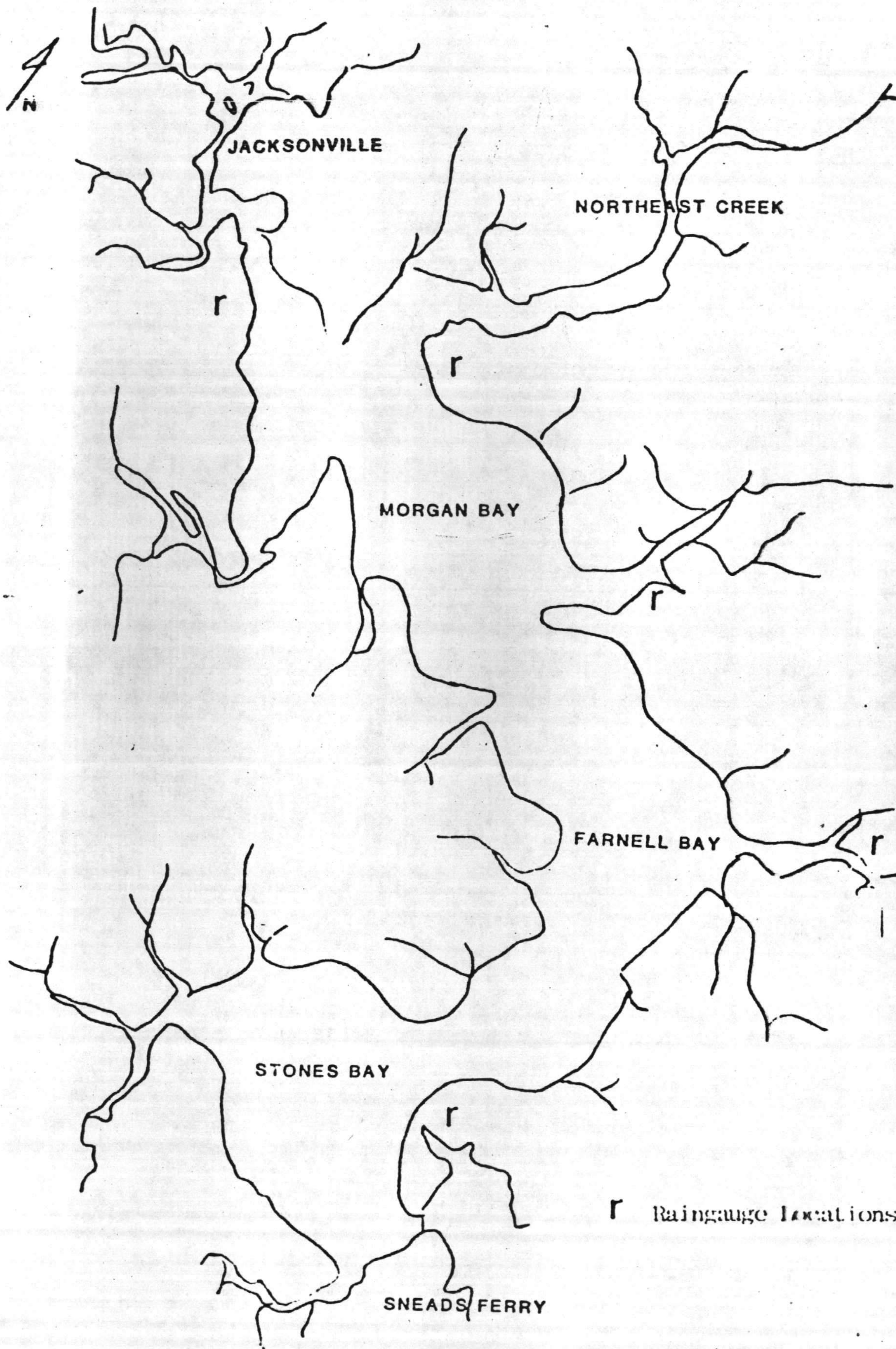

N
JACKSONVILLE
1
NORTHEAST CREEK
2
MORGAN BAY
3
4
FARNELL BAY
5
STONES BAY
7
6
SNEADS FERRY

water surface by a gloved hand with the bottle mouth facing upstream. The bottles were filled so that 25 ml of air were left in the top. The samples were stored on ice during transit to the laboratory. No more than six hours elapsed from collection time to laboratory processing. In the field, salinity was determined with a hand-held refractometer (All commercial suppliers are listed in Appendix II); water and air temperatures were recorded with a mercury thermometer. Phosphate, nitrate, dissolved oxygen and turbidity were determined using the Hach DR-EL/4 tests following the manufacturers specifications. Dissolved oxygen was determined with a portable field oxygen meter. Rainfall measurements were obtained from Tru-check rainfall gauges (locations on Figure 3); and additional information was obtained from the Environmental Center at Camp Lejeune Marine Base and the Camp Lejeune Air Station.

LABORATORY ANALYSIS

The coliform counts, fecal streptococci counts and Pseudomonas aeruginosa counts were determined following recommended protocols taken from Standard Methods for the Examination of Water and Wastewater (American Public Health Association, 1975). The table for calculating MPN from MICROBIOLOGICAL METHODS FOR MONITORING THE ENVIRONMENT: WATER AND WASTES (Environmental Protection Agency, 1978) was used.

FIGURE 3. MAP SHOWING LOCATION OF RAIN GAUGES IN STUDY AREA


N
JACKSONVILLE
NORTHEAST CREEK
MORGAN BAY
FARNELL BAY
STONES BAY
SNEADS FERRY
r
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r Raingauge Locations

COLIFORM COUNTS

Presumptive Test

Upon returning the water samples to the laboratory, 1 ml from each sample was placed into each of 5 test tubes containing single-strength lauryl tryptose broth. Additional dilutions were made so that 1 ml of the 0.1 dilution and 1 ml of the 0.01 dilutions were inoculated into each of a set of 5 test tubes containing single-strength lauryl tryptose broth. All dilutions in this study were performed using sterile phosphate buffer as the diluent.

An inverted Durham tube was placed in each test tube to collect gases. A positive presumptive test shows gas formation after incubation of 24 hours or 48 hours at 35°C.

Confirmed and Fecal Coliform Tests

Each positive presumptive test was used to inoculate an EC Broth and a 2% Brilliant Green Bile (BGB) Broth. Inoculation was performed with a sterile wooden swab submerged once around the positive lauryl tryptose tube, then once around the EC tube and finally once around the BGB tube. The EC medium was incubated in a water bath at 44.5°C for 24 hours. The BGB medium was incubated at 35°C for 24 hours or 48 hours. The formation of gas in an inverted Durham tube of the BGB tube indicates a positive test for total coliform bacteria while gas formation in the EC medium indicated a positive reaction for fecal coliforms.

In this report, the total coliform count for an area (or station) represents the log (geometric) mean of the MPN's of the

confirmed coliform count (BGB) for all samples from the area (or station). The fecal coliform count is likewise the geometric mean of the MPN of the positive EC broths for all samples within an area (or station).

Completed Test

The positive confirmed tubes (BGB) were inoculated onto Eosin Methylene Blue (EMB) agar plates. The plates were incubated at 35°C for 24 hours and were used to tentatively identify Escherichia coli which forms typical colonies with a dark metallic green sheen on EMB agar. The appearance of typical E. coli colonies on the EMB medium was taken as a positive completed coliform test and was used to verify the confirmed coliform results.

FECAL STREPTOCOCCI

Presumptive Test

Water samples were diluted so that 1 ml of the undiluted sample, 1 ml of a 0.1 dilution, and 1 ml of a 0.01 dilution were placed into sets of single strength azide dextrose broth. Five tubes of broth were inoculated from each dilution. The inoculated test tubes are incubated at 35°C for up to 48 hours. A positive presumptive test shows turbidity after incubation.

Confirmed Test

Each positive azide dextrose broth was transferred to a tube of ethyl violet azide broth. The transfer was performed with a sterile wooden swab from the azide dextrose to the ethyl violet

azide broth. The inoculated tubes are incubated for 48 hours at 35°C. A positive confirmed test was indicated by the formation of a purple button at the bottom of the tube or occasionally by a dense turbidity.

PSEUDOMONAS AERUGINOSA

Presumptive Test

Using the same dilution pattern as with the coliform and fecal streptococci analyses, a set of five tubes of asparagine broth were inoculated. The inoculated tubes were incubated at 35°C for 24 to 48 hours. Tubes which fluoresced when exposed to long wave ultra-violet light were considered positive presumptive tests.

Confirmed Test

One drop of asparagine broth was removed from a positive presumptive tube and placed on an acetamide agar slant. The tubes were incubated at 35 to 37°C for 24 to 36 hours. A positive confirmed test was indicated by the development of an alkaline pH in the medium as indicated by a purple color.

SURVEY

A survey was taken to determine the use of the New River by commercial and recreational boaters and fishermen. A list of the addresses of owners with boat permits was obtained from the North Carolina Division of Marine Fisheries. A random selection of 200 owners were sent questionnaires (Appendix III and Table 8) and

another 62 questionnaires were sent to local fishing clubs.

RESULTS

A summary of all the bacteriological data collected during this study is contained in Appendix I. For data analysis, samples were grouped into 14 sampling areas (Figure 1) each of which usually included several sites that were sampled between 1 and 18 times during the study period. Seven major stations were also emphasized. These stations were single sample sites where an attempt was made to collect samples at least monthly during this study.

Table 1 lists a summary of the pertinent data for all sampling areas and the major stations. During the study, total coliform counts were found to range between 0 to 24,000 per 100 ml. Fecal coliform counts varied from 0 up to 16,000 per 100 ml. In general, both fecal and total coliform counts were higher in the stream samples and lower in the mid-bay samples.

The fecal coliform counts were highest in the river north of and adjacent to Jacksonville (Table 2). Fecal coliform counts were also high in several of the streams entering the bay (e.g. Wallace Creek and Stones Creek). The lowest values occur in Stones and Farnell Bays which had high tidal fluctuation, deep water and lower human population on adjoining land areas. Several mid-bay areas had a fecal coliform average below 14/100 ml which is the recommended maximum median for commercial shellfish collection.

Table 1. Summary of Bacteriological Data

Sampling Area	Approximate Location	No. of Sites	No. of Samples	Log Mean Fecal Coliform	Log Mean Total Coliform	% Sites Fecal Coliform Above * 14/100 ml	% Sites Above SA ** Standards	% Sites Above SB Standards	% Sites Above SC Standards
Area A	North of Jacksonville	6	21	94	876	100	100	17	0
Area B - Station 6	Jacksonville	1	16	105	1076	100	100	0	0
Area C	Montford Point	6	26	33	600	83	100	0	0
Area D - Total	Southwest Creek	6	28	61	829	60	100	17	0
Area D - Station 4	Mill Run Creek	1	9	335	855	100	100	100	0
Area E	Upper Morgan Bay	1	2	0	4	0	0	0	0
Area F - Total	Northeast Creek	9	44	41	787	67	100	11	0
Area F - Station 2	Northeast Creek	1	15	92	2094	100	100	0	0
Area G	Lower Morgan Bay	7	28	17	375	71	100	0	0
Area H - Total	Wallace Creek	3	30	63	1551	100	100	33	0
Area H - Station 3	Mouth of Wallace Creek	1	18	31	669	100	100	0	0
Area I	Upper Farnell Bay	4	18	7	50	25	25	0	0
Area J	Lower Farnell Bay	3	13	2	16	0	0	0	0
Area K - Total	Frenchs Creek	8	57	39	308	88	63	13	0
Area K - Station 5	Cowhead Creek	1	11	60	385	100	100	0	0
Area L - Total	Stones Creek	7	45	70	287	100	100	29	0
Area L - Station 7	Dixon	1	9	151	1000	100	100	0	0
Area M	Stones Bay	4	17	2	29	25	25	0	0
Area N - Station 6	Pollocks Point	1	11	2	9	0	0	0	0

*Standard for shellfish harvesting water as designated by North Carolina Department of Human Resources

**SA standard = 70 total coliform /100 ml
SB standard = 200 fecal coliform /100 ml
SC standard = 1000 fecal coliform /100 ml

NOTE: SA, SB, SC standards adopted from North Carolina Department of Natural Resources and Community Development Guidelines. Log means used in this study are annual means and not just May through September means required for accurate SB classification.

Table 2. List of Sampling Areas in Descending Order of Fecal Coliform Levels.

Sampling Area	Approximate Location	Log Mean Fecal Coliform	Log Mean Total Coliform
B	Jacksonville	105	1076
A	North of Jacksonville	94	876
L	Stones Creek	70	287
H	Wallace Creek	63	1551
D	Southwest Creek	61	829
F	Northeast Creek	41	787
K	Frenchs Creek	39	308
C	Montford Point	33	600
G	Lower Morgan Bay	17	375
*			
I	Upper Farnell Bay	7	50
J	Lower Farnell Bay	2	16
M	Stones Bay	2	29
N	Pollocks Point	2	9
E	Upper Morgan Bay	0	4

*Line represents maximum fecal coliform count considered acceptable for water in which commercial shellfish are taken (as defined by the North Carolina Department of Human Resources, Shellfish Sanitation Standards).

Total coliform counts were also lowest in the middle water of the estuary. Highest total coliform counts occured along the northeast shore of the bay especially in Wallace Creek and near Jacksonville (Table 3). Other areas with relatively high total coliform counts were Northeast and Southwest Creek.

Most of the study area was rural and unpopulated. The exceptions were Jacksonville (Station 1), Northeast Creek (Station 2), the mouth of Wallace Creek (Station 3) and Dixon (Station 7). These areas were thought to contribute to the bacterial concentration in the New River area (Table 4).

Salinity, turbidity and water temperature in the New River showed no distinguishable pattern relative to bacterial counts (For data see Appendix I). No correlation was found between salinity and either the average total coliform counts (r=-0.34, 15df) or average fecal coliform counts (r=-0.44, 10df). No correlation was noted between turbidity and fecal coliform counts (r=-0.16, 6df) or turbidity and total completed coliform counts (r=-0.19, 6df). Rainfall, on the other hand, was highly correlated with total completed coliform counts (r=-0.65, 10df) and fecal coliform counts (r=-0.61, 10df). Rainfall (Table 5) was highest in August (9.65 inches), followed by June and May with 7.85 and 7.14 inches, respectively an these months generally had high bacterial counts.

Table 6 shows the number, ratio and expected source for fecal coliform counts and fecal streptococci counts originating from suspected animal and human sources. Table 7 shows the number, ratio and expected source for fecal coliform counts and

Table 3. List of Sampling Areas in Descending Order of Total Coliform Levels.

Sampling Area	Approximate Location	Log Mean Total Coliform	Log Mean Fecal Colform
H	Wallace Creek	1551	63
B	Jacksonville	1076	105
A	North of Jacksonville	876	94
D	Southwest Creek	829	61
F	Northeast Creek	787	41
C	Montford Point	600	33
G	Lower Morgan Bay	375	17
K	Frenchs Creek	308	39
L	Stones Creek	287	70
*			
I	Upper Farnell	50	7
M	Stones Bay	29	2
J	Lower Farnell Bay	16	2
N	Pollocks Point	9	2
E	Upper Morgan Bay	4	0

*Line represents the maximum total coliform count acceptable for class SA water as designated by the North Carolina Department of Natural Resources and Community Development's "Classification and Water Quality Standards."

NOTE: Samples above the line are probably best classified as meeting SB class water standards.

Table 4. List of Major Sampling Stations Ranked in Descending Order of Fecal Coliform Counts

Station	Approximate Location	Log Mean Fecal Coliform	Log Mean Total Coliform
4	Mill Run Creek	335*	855
7	Dixon	151	1000
1	Jacksonville	105	1076
2	Northeast Creek	92	2094
5	Cowhead Creek	60	385
3	Wallace Creek	31	669
**			
6	Pollocks Point	2	9

*Station 4 exceeds established standards for SB class water (fecal coliform counts exceed 200 per 100 ml).

**Line represents (a) maximum permissible limit of fecal coliform counts (14/100 ml) for shellfish harvesting as established by North Carolina Department of Human Resources and (b) maximum permissible limit for total coliform counts (70/100 ml) for SA class water as established by North Carolina Department of Natural Resources and Community Development.

TABLE 5 - MONTHLY RAINFALL RESULTS

	RAINFALL IN INCHES
November 1980	.39
January 1981	.85
February 1981	1.76
March 1981	1.83
April 1981	.53
May 1981	7.14
June 1981	7.85
July 1981	1.97
August 1981	9.65
September 1981	1.80
October 1981	.81
November 1981	.92

**Data received from Environmental Center, Camp LeJeune, North Carolina and New River Air Station, Jacksonville, North Carolina*

TABLE 6 - FECAL STREPTOCOCCI RESULTS

STATION CODE NO.	FECAL COLIFORM /ml	FECAL STREPTOCOCCI /ml	RATIO	Expected source GEOGRAPHIC	Expected source BACTERIAL
35	490	130	3.77	human	human
36	130	330	0.39	human	animal*
44	0	45	0.02	animal	animal
52	0	130	0.01	human	animal
93	45	130	0.35	animal	animal*
108	230	1700	0.14	animal	animal
130	45	340	0.13	animal	animal
132	170	1100	0.15	animal	animal
156	0	45	0.02	animal	animal
176	45	0	4.5	human	human
185	3500	78	44.8	animal	human
186	790	330	2.39	animal	human *
247	2400	1300	1.85	animal	human *
249	230	3500	0.06	animal	animal
250	1300	220	5.91	animal	human
262	78	490	0.16	animal	animal
265	170	790	0.22	animal	animal
273	45	170	0.26	animal	animal
274	230	61	3.77	animal	human *
275	78	330	0.24	animal	animal
306	45	18	2.5	animal	human *
315	460	170	2.71	animal	human *
321	78	0	7.8	animal	human
345	1300	3300	0.39	animal	animal
353	490	140	3.5	human	human *
354	2800	16000	0.17	human	animal
355	490	3500	0.14	human	animal

* probable source

TABLE 7 - PSEUDOMONAS AERUGINOSA RESULTS

STATION CODE NO.	FECAL COLIFORM /ml	P. AERUGINOSA /ml	RATIO	Expected source GEOGRAPHIC	BACTERIAL
1	68	0	6.8	animal	animal
6	78	20	3.9	animal	animal
13	48	0	4.5	animal	animal
32	130	20	6.5	human	animal
34	1300	0	130.0	human	animal
35	490	0	49.0	human	animal
36	130	45	2.89	human	animal*
43	170	20	8.5	animal	animal
51	0	68	0.14	human	human
80	490	20	24.5	animal	animal
91	230	1300	0.17	animal	human
92	68	0	6.8	animal	animal
93	45	0	4.5	animal	animal
95	78	20	3.9	animal	animal
107	430	3500	0.12	animal	human
108	230	0	23.0	animal	animal
109	78	20	3.9	animal	animal
130	45	0	4.5	animal	animal
131	45	0	4.5	animal	animal
140	310	37	8.38	animal	animal
141	1300	0	130.0	animal	animal
142	170	0	17.0	animal	animal
173	310	1300	0.24	animal	human
174	330	20	16.5	animal	animal*
176	45	0	4.5	animal	animal
177	120	20	6.0	animal	animal
184	430	1300	0.33	animal	human
185	3500	0	350.0	animal	animal
186	790	0	79.0	animal	animal
216	310	3500	0.08	human	human
222	78	0	7.8	animal	animal
228	0	45	0.02	animal	human
246	330	110	3.0	animal	animal*
247	2400	0	240.0	animal	animal
248	1200	0	120.0	animal	animal
249	230	0	23.0	animal	animal
250	1300	20	65.0	animal	animal
261	230	18	12.7	animal	animal
263	230	0	23.0	animal	animal
264	140	0	14.0	animal	animal
265	170	0	17.0	animal	animal
266	68	0	6.8	animal	animal
271	230	68	3.38	animal	animal*
272	140	45	3.11	animal	animal*
273	45	0	4.5	animal	animal
274	230	0	23.0	animal	animal

*probable source

TABLE 7 CONTINUED

STATION CODE NO.	FECAL COLIFORM /ml	P. AERUGINOSA /ml	RATIO	Expected source GEOGRAPHIC	BACTERIAL
275	78	0	7.8	animal	animal
276	110	0	11.0	animal	animal
279	230	68	3.38	animal	animal
306	45	0	4.5	animal	animal
314	230	20	11.5	animal	animal
315	460	0	46.0	animal	animal
316	490	45	10.8	animal	animal
346	230	20	11.5	animal	animal
353	490	0	49.0	human	animal
354	2800	0	280.0	human	animal
355	490	20	24.5	human	animal
360	310	3500	0.09	animal	human
364	45	0	4.5	animal	animal

Pseudomonas aeruginosa counts. A correlation (r=-0.72, 49df) was found between the *P. aeruginosa* counts and fecal coliform counts originating from suspected human sources.

The results of the area use survey are compiled in Table 8. Most responses to question 1 consisted of two or more answers. Recreational fishing and shellfishing has the most participants; recreational boating is the second most popular activity. About 52% of the respondents use the river an average of 5.5 times per month and 30% use it once a month. The average respondent has fished 15.6 years in the area (range 3-35 years) and plans to fish for 20.5 more years.

The average boat, valued at $3,536, is 17.6 feet long and carries an average party of 1.94 males and 0.6 females. The average trip is 4.8 days and at least half of the respondents either will live or stay overnight in the county. Of the 56 respondents, 55 own their boats. Public boat ramps are used by 60% of the respondents, 21% prefer private ramps and 18% use both types. Over 80% of the respondents spend less than $50 per trip. In the past twelve months, those polled (52%) spent an average of $100-500 on boat expenses and gear.

Sport fishermen comprised 46% of the respondents and only 19% sell their catch. Thirty-two of 52 (58%) caught between 100-500 pounds of fish this year with only one over 10,000 pounds. Fishermen were generally after no specific catch (69%). Gill nets and pole line are the predominant gear with drifting and casting being the method most often used in the river.

Although it is difficult to determine the amount of money

spent in the county on a trip, most of the respondents (63%) felt that they would have spent up to $10 in Onslow County if they knew they would not catch anything on the trip. The occupations of the respondents are diverse. Of the respondents, 31% had incomes between $10,000-15,000 and only one exceeds $40,000.

TABLE 8 - RESULTS OF 56 SURVEYS RETURNED FROM INDIVIDUAL FISHERMEN

ALL ANSWERS WILL BE KEPT CONFIDENTIAL

1. What is the nature of your activity in the New River area? (check all that apply)
   (15) swimming
   (34) recreational boating
   (50) recreational fishing and/or shellfishing
   (21) commercial fishing and/or shellfishing

2. Approximately how often do you use the New River for your activity?
N=29 (5.5)/month Range 1-15 (✓)/month-8
N=10 (12.1)/year Range 3-50 N/A-2 (✓)/year-5

3. Which general area do you usually use for your activity? (Refer to charts and/or maps)
(16)A(24)B (24)C (17)D(28)E (28)F (26)G (13)H(21)I (19)J (10)K (18)L
(3) M(29)N N/A-1

4. How many years have you fished in this area?(15.6)years N/A 1 Range 3-35

5. For how many years in the future do you expect to fish in the New River area?
(20.5) years Life-17 Range 1-life

6. If you used a boat on your last trip: Type of boat( )
Length of boat (17.6)ft. Range 12-21
Number in party (1.94)males (.6)females Σ = 2.54
How many days spent in area on trip? (4.8)days N/A 14
Is this your own boat? (55)yes ( )no N/A-1
Did (will) you stay overnight in this county as a result of this trip?
(21)yes (22)no N/A-3
At a private residence (28)yes (9)no N/A-9
Public lodging (7)yes (25)no N/A-15

7. Approximately what were the total expenses incurred on this trip in Onslow County? (41)0-$50 (83%) (4) $100-$500 (8%) (1) over $1000 (2%)
(3)$50-$100 (6%) ( ) $500-$1000 N/A-7

8. Where do you usually launch your boat? (12)private (21%) (33)public (6%) Both-10 (18%) N/A-1

9. What is the approximate value of your boat and gear?
(2) less than $500 (4%) ( ) $20,000-$50,000
(14) $500-$1000 (25%) ( ) $50,000-$100,000
$\bar{X}$=3536 (32) $1000-$5000 (57) (1) $100,000-$500,000 (2%)
(7) $5000-$20,000 (1.25%) ( ) more than $500,000

10. How much have you spent in the last 12 months on boat expenses and gear?
(6)less than $100 (11%) (2) $5000-$20,000 (4%)
(29) $100-$500 (52%) ( ) $20,000-$50,000
(9) $500-$1000 (16%) ( ) more than $50,000
(10) $1000-$5000 (18%)

11. If fishing...what percent:

sport or recreational	commercial
(2) 0-5 (4%)	(8) 0-5 (51%)
(7) 5-10 (14%)	(3) 5-10 (11%)
(7) 10-25 (14%)	(3) 10-25 (11%)
(5) 25-50 (9%)	(3) 25-50 (11%)
(7) 50-75 (14%)	(3) 50-75 (11%)
(24) 75-100 (16%)	(6) 75-100 (23%)

12. Is your catch sold? (10)yes (19%) (44)no (81%) N/A-2

13. Approximately how many pounds did your total catch weigh during the past 12 months?

(16) 0-100 (29%)
(32) 100-500 (58%)
(3) 500-1000 (5%)
(1) 1000-5000 (2%)
(2) 500-10,000 (4%)
(1) 10,000-20,000 (2%) N/A-1
( ) 20,000-50,000
( ) more than 50,000

14. Is your fishing activity for a particular species? (17) yes (31%) (37) no (69%) N/A-2

15. What type of fishing gear and method do you usually use? (Check all that apply)

gear
(43) pole and line
(47) gill net
(11) seine
(14) cast net (bait)
(20) rake, tong
(27) gig
(3) dredge
(2) other Crab Pot
(1) Eel Pot

method
(23) trawling
(29) still fishing
(39) drifting
(36) casting
(1) other Shrimp Trawl (20 ft net)
(1) Setting net

16. If you knew in advance that you wouldn't have caught anything in the bay area today, how much money would you have spent on some other activity in Onslow County?

(31) $0-10 (63%)
(15) $10-$50 (31%)
(1) $50-$100 (2%)
(1) $100-$300 (2%)
( ) $300-$500 N/A-7
(1) more than $500 (2%)

17. What is your occupation? ( )

18. Would you indicate which catagory most closely corresponds to your income for the past 12 months?

(6) less than $5000 (12%)
(7) $5000-$10,000 (13%)
(16) $10,000-$15,000 (31%)
(9) $15,000-$20,000 (17%)
(8) $20,000-$30,000 (15%)
(5) $30,000-$40,000 (9%) N/A-4
(1) $40,000-$50,000 (2%)
( ) more than $50,000

19. Comments on improving the use of the New River

6. Type of boat

Skiff - 13
Fiberglass - 3
Trihull - 2
Wood - 2
Allendale - 2
Aluminum - 2
Bass - 2
Well boat
Open whaler
Cruiser
McKee craft
Phillips
Dixie
I-O
Manatee
Porter
Outboard
Canoe
Atlantic
Trawler (80 ft.)
Pleasure

N/A - 16

17 Occupation

Veterinarian
Dentist
Principal
Teacher
Civil Service - 2
Salesman - 2
Manager - radio station
Office Manager
Plant manager - Oil Co.
Insurance agent
Parts manager
Life insurance salesman
Merchant
Store clerk
Production leader
N.C. Marine Fisheries
Telephone Co. - 4
Construction worker - 2
Fireman
Industry
Lineman
Electrician
Courier
Welder
Painter
Heavy equipment operator
Refrigeration
General maintenance person
DVAA assistant
Auto mechanic
Bait and tackle shop
Body repairman
Fishermen - 3
Farmer
Unspecified - 5
Student
Unemployed
Retired - 9

N/A - 2

DISCUSSION AND CONCLUSION

In this study, we tried to determine the impact of fecal pollution on the New River Estuary. We attempted to assess the coliform bacteria distribution and tried to define point and non-point sources of pollution in the estuary. During the 1980-1981 sample year, high coliform levels occured around the city of Jacksonville, Wallace Creek and in the head waters of all the smaller creeks; lower levels occured in the bay. We postulated at the beginning of the study and our data showed that the high coliform counts around Jacksonville are due to increased population. The reduced numbers in the bay areas are probably due to high tidal fluxuation and greater depth of the water. Another possible explanation of the low coliform counts in the bay is debilitation and dilution of the bacteria by salty water. When the bacteria enter salt water, they become stressed, will not grow on selective media and are out-competed by the other bacteria (Dawe and Penrose, 1978).

This study shows that much of the mid-bay areas appear suitable for commercial shellfish harvesting. The lower portion of Morgan Bay (Area G) had fecal and total coliform numbers (perhaps derived from the effluent of Wallace Creek) sufficiently high to make the water unsuitable for shellfish collection (see Tables 2 and 3), but upper Morgan Bay (Area E), upper and lower Farnell Bay (Area I and J), Stones Bay (Area M) and Pollocks Point (Area N) all appear to qualify as safe (Table 2) for shellfish harvesting (i.e. less than 14 fecal coliforms per 100

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

ml as designated by the North Carolina Department of Human Recources' Shellfish Sanitation Standards) and could be classified (Table 3) as SA grade water (i.e. less than 70 total coliforms per 100 ml as designated by North Carolina Department of Natural Resources and Community Development's Classification of Water Quality Standards). With the exception of sites in Wallace Creek (Area H) and an area of the river in downtown Jacksonville (Area B), the remainder of the areas sampled in this study could be classified as class B or SB water (i.e. major criterion less than 200 fecal coliforms per 100 ml). Both the Wallace Creek site and the Jacksonville area exceeded the SB standard in only one respect; their fecal coliform log mean was not above the 200 per 100 ml (Table 3) limit but over 20% of the samples had counts above 400 per 100 ml (Appendix I). These areas and the other sampling areas mentioned above were not sampled "5 times within a 30-day period" as designated in the State's Water Quality Classification Scheme. Furthermore, an annual log mean was used in this study to estimate fecal coliform levels rather than just the May through September sample mean designated in the State's Classification Scheme for class SB waters. Despite these shortcomings, the data are valid in other respects and can be used to estimate water quality. Clearly, Wallace Creek and the Jacksonville area of the river have suffered the most from fecal pollution. Furthermore, the fecal coliform to fecal streptococci ratios at these sites suggest that this pollution may be the result of human fecal pollution. However, the Pseudomonas aeruginosa data does not support this conclusion and suggests

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

that the fecal pollution is of animal origin. This contradiction in data cannot be resolved without additional study.

Our data indicates that the outfalls are probably not the primary source of coliform pollution in the river and that the present discharge system is acceptable. Any large increase in the human population, such as would happen with expanded land development, could tax the sewage system. Growth in this area should be accompanied by evaluation of the capability of all existing sewage disposal and septic systems handlig wastes. Sources contributing significantly to the high coliform counts in the river are land runoff, wildlife and sanitary landfills (Northeast Creek). This can be seen in the generally higher bacterial counts seen in the major stations which were on the edges of the bay compared to the counts in the sampling areas which included mid-bay samples (Tables 2 and 4).

Salinities were poorly correlated with the total completed coliform and fecal coliform numbers found at stations throughout the estuary; thus, salinity was not thought to be an important influence on bacterial numbers in this estuary. Similar results were found with temperature, but rainfall showed a relationship. We, therefore, feel that rain is the main influence on coliform counts in this estuary.

We think that sources other than sewage outfalls are the main cause of coliform pollution in the New River. It appears that agricultural use, extensive forest land and the presence of the Camp Lejeune Marine Base effect bacterial densities in the bay. Specific local activities observed during the study which

are thought to influence the bacterial densities include:

1) U.S. Marine field exercises.

2) Extensive deer herds.

3) Domestic animals in the agricultural areas.

4) Increased runoff volume as a result of the removal of natural ground cover for construction activities.

The results of the analysis for fecal streptococci and Pseudomonas aeruginosa support this theory. If the fecal streptococci to fecal coliform ratio is greater than 4.0, it indicates domestic sewage and ratios of 0.6 indicate animal-related coliforms. This ratio indicates the source of most of the coliforms in the New River are probably animal (Table 5).

In this study of the New River, our data resembles Cabelli's (1976) data from Lake Michigan. In both the New River and Lake Michigan, the Pseudomonas aeruginosa counts, when related to fecal coliforms, indicate the pollution source. If Pseudomonas aeruginosa is low and fecal coliform is high, the source is again believed to be animal. Table 6 further supports the hypothesis that most of the New River coliform is of animal origin.

In this study, the total coliform counts rise to a high during February then diminish to a low in April. The counts rise again in June, drop in July and climb in August. The counts remain high in the fall and drop as winter begins. This pattern holds true for all areas except Stones Bay, where the counts are low throughout the year with a peak in late summer and again in the late fall. The fecal coliform counts follow the same pattern

as the total coliform counts throughout the year. The only major exception is in Stones Bay in mid-fall when the counts rise and then drop again in late October before they rise in late November. This seasonal change did not appear to be related to temperature; that is, no correlation was found. However, it was related to the amount of rainfall. During the sample year, the highest monthly rainfall accumulations were in May, June and August with a correspondingly high bacterial count due to increased land runoff. This pattern does not apply to Stones Bay where the dilution is already high so the increased runoff has little or no effect.

The magnitude and value or assorted water-related activities on the New River is unknown. However, undesirable levels of fecal coliform in the New River would certainly create countywide economical and sociological problems. The impact of closing of the river to commercial and recreational activities is presently unknown. Therefore, a survey was utilized to evaluate the potential economic losses of closing the river to Onslow County residents. Out of 1200 potential users, the 56 (5%) who responded to the questionnaire were used to give an indication of the use of the river. The majority of the respondents use the river for commercial or recreational fishing. Half of the respondents use the river an average of 5.5 times per month and 17% use it one time per month. Using these percentages, we estimated that approximately 1000 persons use the river at least once per month.

The New River estuary has been used extensively for recreational boating, crabbing and fishing. As the local

population increases, recreational use of the area will also likely increase. More than 20,000 people per year use the Camp Lejeune Marina alone. Based upon a recent Jacksonville survey, which has been accepted as representative of Onslow county (Horace Mann, 1981), at least 14% of the population is involved in boating and another 12.5% would like to do so. Additionally, 34.5% of the population of Jacksonville actively fish on the New River, with an additional 14.3% desiring to do so. Finally, the seafood harvesting and processing industries add approximately $10,000,000 to the economy of Onslow County (CAMA, 1980).

An increase in the present bacterial levels, and contamination would be detrimental to recreational and commercial uses of the New River. For example, during the last part of April, 1981, the river was closed to human immersion, fishing and crabbing by order of the North Carolina Shellfish Sanitation Department. This resulted in decreased public spending for recreational activities and loss of income to local commercial fishermen.

Analysis of field and laboratory data collected during this study on bacteriological contamination of the New River, Onslow County, North Carolina, has led to the following conclusions:

1) High total coliform and fecal coliform counts appear to be concentrated around the populated areas of Jacksonville City and in Northeast, Frenchs and Wallace Creeks.

2) Most coliform counts appeared to be from non-point sources and could be attributable to run-off waters from

agricultural pastures, wildlife and sanitary landfills.

3) Fecal streptococci and Pseudomonas aeruginosa data indicate that the non-point coliform pollution is most likely of an animal origin.

4) Seasonal patterns of coliform distribution showed peaks in February, June and August, probably due to increased rainfall during these months.

5) Increased counts of coliform bacteria will be detrimental to recreational and commercial use of the New River watershed area, while decreased counts will tend to benefit its socio-economic growth and stability.

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Key Code to Appendix I

Sta Station Number Identifer Code

S Salinity (0/00)

Tur Turbidity (FTU)

At Air Temperature (°C)

Wt Water Temperature (°C)

Lt Lauryl Tryptose broth COLIFORM PRESUMPTIVE

BGB Brillant Green Bile broth T. COLI CONFIRMED

EC EC broth F. COLI CONFIRMED

EMB Eosine Methylene Blue Agar T. COLI COMPLETED

Asp Asparagine broth P. AERUG PRESUMPTIVE

Act Acetamide Agar P AERUG CONFIRMED

AZD Azide Dextrose broth F. STREP PRESUMPTIVE

EVA Ethyl Violet Azide broth F STREP CONFIRMED

Vib Vibrio sp.

D.O. Dissolved Oxygen (ppm)

Appendix I is summary data from November 30, 1980 to December 7, 1981, New River Estuary

APPENDIX I

	#	Sta	S	Tur	At	Wt	Lt	DCB	EC	ENB	Asp	Act	N2D	FVA	Vib	[illegible]
A	1	SCB $12/7_5$I	0	45	13	9.0	490	220	68	110	45	0	220	93	0	[illegible]
	2	SCB $1/9_1$I	0	95cm	8	5.2	2400	790	490	270	-	-	-	-	-	[illegible]
	3	SCB $3/18_{12}$I	1	30	19	13	320	110	45	68	-	-	-	-	-	-
	4	SCB $6/11_{13}$I	0	110	28	39	9200	3500	78	68	-	-	-	-	-	-
	5	SCB $7/10_{14}$I	1	55	32	30.5	790	490	100	68	-	-	-	-	-	[illegible]
	6	SCB $8/29_{10}$I	0	26	30	23	2800	1800	78	92	92	20	-	-	-	[illegible]
	7	SCB $11/30_1$I	0	45	0.5	9.5	3200	920	170	540	-	-	-	-	-	-
	8	SCB $3/18_{11}$I	3	30	18	12	490	110	78	45	-	-	-	-	-	-
	9	SCB $6/11_{12}$I	0	79	38	29	480	340	45	140	-	-	-	-	-	-
	10	SCB $7/10_{13}$I	1	45	32	30	5400	5400	68	130	-	-	-	-	-	[illegible]
	11	SCB $6/11_{11}$I	0	105	37	27	5400	1100	130	210	-	-	-	-	-	-
	12	SCB $7/10_{12}$I	1	45	33	30	790	790	20	68	-	-	-	-	-	6.8
	13	SCB $8/29_9$I	0	30	29	23	790	490	45	0	0	0	-	-	-	4.5
	14	SCB $1/9_2$I	0	61	8	5.2	3500	1700	230	490	-	-	-	-	-	-
	15	SCB $3/18_{13}$I	4	30	20	11.5	790	490	45	78	-	-	-	-	-	-
	16	SCB $8/29_8$I	0	55	35	28	16000	5400	68	68	-	-	-	-	-	-
	17	SCB $7/10_{11}$I	4	75	33	34	24000	5400	45	68	-	-	-	-	-	6.7
	18	SCB $8/29_8$I	0	30	30	24	1700	790	20	83	0	0	-	-	-	5.1
	19	SCB $11/30_2$I	0	18	18	7.6	3200	3200	920	29	-	-	-	-	-	-
	20	SCB $1/9_4$I	0	-	6	5	3200	3200	1100	1400	-	-	-	-	-	11.0
	21	SCB $3/18_{14}$I	2	38	20	11	1300	110	40	20	-	-	-	-	-	-
B	22	SCB $1/9_5$I	0	58	4.5	4.2	9200	3500	460	170	-	-	-	-	-	10.8
	23	SCB $2/28_1$I	2	40	19	11	790	330	130	330	-	-	-	-	-	-
	24	SCB $3/18_9$I	8	25	18	12	1700	45	40	0	-	-	-	-	-	-
	25	SCB $3/18_{10}$I	6	35	18	12	220	45	20	20	-	-	-	-	-	-
	26	SCB $5/13_1$I	0	-	24	23	24000	24000	16000	320	-	-	-	-	-	-
	27	SCB $6/11_9$I	0	90	34	28	2400	790	20	130	-	-	-	-	-	-
	28	SCB $6/30_1$I	3	70	28	27	2400	2400	1300	270	-	-	-	-	-	-
	29	SCB $7/10_{10}$I	4	35	33.5	31.5	9200	260	0	40	-	-	-	-	-	6.6
	30	SCB $7/24_1$I	8	20	30	30	1600	5400	230	20	1300	-	-	-	-	-

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APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	DGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
31	SCB 8/20$_1$I	2	75	23	22	24000	24000	230	140	700	170	-	-	-	7.5
32	SCB 8/29$_{11}$I	2	32	29	24.5	1300	790	130	130	45	20	-	-	-	4.0
33	SCB 9/25$_1$I	5	-	25	21	3500	1300	20	120	0	0	700	20	1	-
34	SCB 10/12$_1$I	4	-	24	16	3500	3500	1300	1700	0	0	1300	1300	2	-
35	SCB 10/31$_0$I	21	110	17.5	16	1700	1700	490	1700	0	0	2400	130	TNTC	-
36	SCB 11/15$_1$I	18	26	15	11	16000	3500	130	330	45	45	490	330	15	-
37	SCB 12/7$_4$I	12	40	14.0	9.0	78	45	0	0	0	0	0	0	0	19
C 38	SCB 11/30$_3$I	2	55	2.2	8.6	3200	3200	540	52	-	-	-	-	-	72
39	SCB 1/9$_6$I	0	55	5	4.3	9200	5400	790	170	-	-	-	-	-	11.7
40	SCB 3/18$_8$I	8	30	17	12	490	170	45	68	-	-	-	-	-	-
41	SCB 6/11$_8$I	0	105	34	29	5400	3500	45	170	-	-	-	-	-	-
42	SCB 7/10$_9$I	5	35	33.5	31	3500	490	230	230	-	-	-	-	-	6.5
43	SCB 8/29$_6$I	0	29	28	25	2400	1300	170	93	45	20	-	-	-	5.2
44	SCB 12/7$_3$I	15	20	15	9	130	130	0	45	0	0	78	45	0	19
45	SCB 1/9$_7$I	0	58	5.5	4	32000	2400	330	170	-	-	-	-	-	-
46	SCB 3/18$_6$I	9	35	17	11	1100	1100	140	170	-	-	-	-	-	-
47	SCB 3/18$_7$I	8	33	17	11	490	230	45	130	-	-	-	-	-	-
48	SCB 6/11$_6$I	1	50	36	29	24000	16000	5400	450	-	-	-	-	-	-
49	SCB 7/10$_7$I	8	45	32	30.5	490	170	0	40	-	-	-	-	-	6.6
50	SCB 7/10$_8$I	9	35	33	31	790	790	20	20	-	-	-	-	-	6.6
51	SCB 8/29$_5$I	4	28	28	26	700	460	0	40	68	68	-	-	-	6.0
52	SCB 12/7$_2$I	9	55	15.5	9.5	330	170	0	78	20	0	230	130	0	19
53	SCB 11/30$_4$I	7	50	6.7	8.8	350	180	130	280	-	-	-	-	-	97
54	SCB 6/11$_5$I	1	80	36	28	2400	1300	78	130	-	-	-	-	-	-
55	SCB 8/29$_4$I	4	30	30	26	330	330	0	0	20	0	-	-	-	5.3
56	SCB 7/10$_6$I	12	30	31.5	31	490	330	20	20	-	-	-	-	-	6.6
57	SCB 4/15$_1$I	10	10	19	22	490	140	0	40	-	-	-	-	-	-
58	SCB 10/31$_2$I	18	85	17	16.5	45	45	0	0	0	0	78	0	TNTC	-
59	SCB 11/15$_2$I	23	17	15	12	2200	1300	170	340	220	220	220	140	8	-
60	SCB 1/9$_8$I	6	60	5.5	5.1	5400	330	50	80	-	-	-	-	-	14.5

APPENDIX I

#	Sta	c	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
61	SCB $3/18_{5}$I	15	21	17	11	110	110	110	68	-	-	-	-	-	-
62	SCB $8/29_{2}$I	4	70	39	29	9200	3500	68	140	-	-	-	-	-	-
63	SCB $8/29_{2}$I	3	26	27	25	1100	790	20	61	45	45	-	-	-	5.9
E 64	SCB $7/10_{5}$I	12	30	32	30.5	0	0	0	0	-	-	-	-	-	6.7
65	SCB $12/7_{1}$I	18	20	14	9.5	20	20	0	0	0	0	20	0	0	16
F 66	SCB $3/18_{3}$II	14	10	17	11	170	68	68	40	-	-	-	-	-	-
67	SCB $6/11_{3}$II	3	55	32	30	1300	1300	45	78	-	-	-	-	-	-
68	SCB $7/10_{3}$II	7	20	33	31.5	110	68	0	45	-	-	-	-	-	6.6
69	SCB $8/29_{2}$II	10	15	27	25.5	3500	1100	45	93	45	45	-	-	-	6.3
70	SCB $4/15_{1}$II	4	12	19	18	2200	950	0	640	-	-	-	-	-	-
71	SCB $2/28_{3}$II	0	20	18	11	270	170	20	110	-	-	-	-	-	-
72	SCB $1/9_{3}$II	-	-	-	4.2	330	230	0	50	-	-	-	-	-	-
73	SCB $3/18_{4}$II	12	16	16	11	45	20	0	20	-	-	-	-	-	-
74	SCB $3/18_{5}$II	12	15	16	11	0	0	0	0	-	-	-	-	-	-
75	SCB $6/11_{2}$II	7	37	35	29	330	130	20	45	-	-	-	-	-	-
76	SCB $7/10_{4}$II	10	35	33	30	130	130	0	78	-	-	-	-	-	6.6
77	SCB $7/24_{3}$II	0	15	27	22	24000	16000	790	61	-	-	-	-	-	-
78	SCB $6/11_{5}$II	3	55	32	30	1300	1300	45	78	-	-	-	-	-	-
79	SCB $7/10_{5}$II	9	30	32	31.5	170	68	0	18	-	-	-	-	-	6.5
80	SCB $8/29_{4}$II	9	18	27	25	3500	3500	490	490	40	20	-	-	-	[illegible]
81	SCB $1/9_{4}$II	-	-	-	5.2	3500	490	50	40	-	-	-	-	-	-
82	SCB $2/4_{1}$II	0	85	-1	4	24000	24000	24000	-	-	-	-	-	-	-
83	SCB $2/28_{2}$II	5	45	19	13.5	1300	490	78	220	-	-	-	-	-	-
84	SCB $3/18_{6}$II	6	17	16	11.5	490	490	20	220	-	-	-	-	-	-
85	SCB [illegible]	9	5	19	23	5400	3500	0	74	-	-	-	-	-	-
86	SCB $5/13_{3}$II	4	-	27	26	9200	9200	130	200	-	-	-	-	-	-
87	SCB $6/11_{6}$II	0	80	33	29	5400	1400	230	130	-	-	-	-	-	-
88	SCB $6/30_{4}$II	6	55	29	27	24000	3400	110	93	-	-	-	-	-	-
89	SCB $7/10_{6}$II	7	30	32	31.5	3500	1100	78	68	-	-	-	-	-	6.6
90	SCB $7/24_{1}$II	8	35	27	30	24000	9200	230	0	2400	-	-	-	-	-

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
91	SCB 8/20$_5$II	1	190	22	22	24000	24000	230	380	1300	1300	-	-	-	5.3
92	SCB 9/25$_2$II	5	-	25	23	1700	790	68	40	0	.0	230	45	42	15.5
93	SCB 10/12$_1$II	14	-	24.5	19	9200	3500	45	110	170	0	330	130	0	-
94	SCB 10/31$_1$II	19	160	21	16	110	110	20	110	0	0	330	0	TNTC	-
95	SCB 11/15$_3$II	20	29	17	12	9200	3500	78	330	40	20	140	93	8	-
96	SCB 1/21$_2$II	0	5	10	8	16000	9200	790	450	-	-	-	-	-	-
97	SCB 5/27$_5$II	1	60	24	20	1700	1300	230	330	-	-	-	-	-	-
98	SCB 1/21$_3$II	0	30	10	8	230	230	230	230	-	-	-	-	-	-
99	SCB 5/27$_4$II	1	50	24	20	2400	790	78	170	-	-	-	-	-	-
100	SCB 5/27$_3$II	1	120	23	20	5400	3500	1300	790	-	-	-	-	-	-
101	SCB 1/21$_4$II	0	165	10	9	32000	16000	5400	1400	-	-	-	-	-	-
102	SCB 5/27$_2$II	2	85	23	20	2200	640	0	0	-	-	-	-	-	-
103	SCB 2/4$_2$II	11	45	-2	7	24000	24000	3500	810	-	-	-	-	-	-
104	SCB 4/15$_8$II	15	0	21	23	230	20	0	20	-	-	-	-	-	-
105	SCB 5/27$_6$II	20	40	22	24	130	78	0	20	-	-	-	-	-	-
106	SCB 7/24$_1$II	14	10	18.5	30	700	700	20	0	-	-	-	-	-	-
107	SCB 8/20$_4$II	10	50	22	23.5	24000	24000	430	200	16000	3500	-	-	-	6.2
108	SCB 10/31$_2$II	5	110	20	16.5	1300	490	230	490	0	0	1700	1700	7	-
109	SCB 11/15$_2$II	21	18	15	10	790	490	78	170	40	20	79	78	1	-
110	SCB 2/28$_4$II	12	30	19	12	130	45	20	45	-	-	-	-	-	14
G 111	SCB 3/18$_2$II	13	19	13	10.5	130	130	20	130	-	-	-	-	-	-
112	SCB 6/11$_1$I	5	50	37.5	28	3500	120	0	18	-	-	-	-	-	-
113	SCB 7/10$_1$I	13	20	30	30	45	20	0	20	-	-	-	-	-	6.5
114	SCB 8/29$_1$I	5	20	27	25.5	490	230	0	78	20	0	-	-	-	8.3
D 115	SCB 11/30$_5$I	5	45	8.4	6.2	1600	1600	350	920	-	-	-	-	-	69
116	SCB 1/9$_{10}$I	0	28	5	2.8	5400	200	20	60	-	-	-	-	-	11.4
117	SCB 3/18$_1$I	10	15	13	11	460	45	0	45	-	-	-	-	-	-
118	SCB 7/10$_2$I	9.	20	30.5	30	790	490	20	110	-	-	-	-	-	6.5
119	SCB 6/29$_2$I	3	26	27	25	1100	790	20	61	45	45	-	-	-	5.9
120	SCB 12/7$_1$I	18	20	14.0	9.5	20	20	0	0	0	0	[illegible]	0	0	16

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	DGB	EC	EMB	Asp	Act	A7D	EVA	Vib	D.O
121	SCB 3/18$_2$I	6	15	12	17	130	45	0	45	-	-	-	-	-	-
122	SCB 6/11$_2$I	2	60	39	30	1300	79	20	37	-	-	-	-	-	-
123	SCB 7/10$_3$I	8	35	31	30	2400	1300	78	78	-	-	-	-	-	6.6
124	SCB 3/18$_3$I	4	16	16	1.5	270	61	0	20	-	-	-	-	-	-
125	SCB 6/11$_3$I	1	60	39	29	1300	490	68	40	-	-	-	-	-	-
126	SCB 7/10$_4$I	6	35	31.5	30	3500	3500	45	120	-	-	-	-	-	6.7
127	SCB 5/27$_3$I	1	60	22	20	790	490	40	68	-	-	-	-	-	-
128	SCB 5/27$_2$I	1	50	22	20	2400	1300	230	490	-	-	-	-	-	-
129	SCB 8/20$_2$I	1	120	23	21	24000	24000	230	92	9200	3500	-	-	-	5
130	SCB 10/12$_2$I	0	-	27	16.5	3500	3500	45	92	790	0	24000	340	90/10	-
131	SCB 10/31$_1$I	0	55	18	16	93	68	45	68	0	0	0	78	0	-
132	SCB 11/15$_3$I	1	22	16	12	3500	2400	170	170	490	93	5400	1100	0	-
133	SCB 1/17$_1$I	0	-	2	2	1700	220	170	170	-	-	-	-	-	-
134	SCB 1/21$_1$I	0	30	10	10	3500	1300	790	1300	-	-	-	-	-	-
135	SCB 2/28$_2$I	0	30	22	10	-	-	-	-	-	-	-	-	-	-
136	SCB 4/29$_1$I	0	5	-	20	490	170	20	68	-	-	-	-	-	-
137	SCB 5/27$_1$I	1	120	24	19	2400	2400	790	1300	-	-	-	-	-	-
138	SCB 4/30$_2$I	1	35	29	19	5400	2200	1100	330	-	-	-	-	-	-
139	SCB 7/24$_2$I	0	55	30	25	2800	2800	330	460	220	-	-	-	-	-
140	SCB 8/20$_3$I	0	110	23	225	24000	16000	310	440	37	37	-	-	-	6
141	SCB 10/12$_1$I	4	-	23	16	3500	3500	1300	1700	0	0	1300	1300	2	-
142	SCB 4/15$_4$I	0	16	15	11	16000	5400	170	5400	0	0	110	110	1	-
G 143	SCB 2/4$_3$II	0	20	-2	4.5	24000	24000	720	810	-	-	-	-	-	-
144	SCB 4/15$_7$II	0	10	23	20	2400	1300	0	170	-	-	-	-	-	-
145	SCB 5/27$_7$II	1	50	23	21	5400	5400	330	220	-	-	-	-	-	-
146	SCB 7/24$_3$II	0	15	27	22	24000	16000	790	61	-	-	-	-	-	-
147	SCB 2/4$_4$II	0	10	0	5	24000	720	150	190	-	-	-	-	-	-
148	SCB 4/15$_6$II	0	17	23	21	2200	2200	0	1100	-	-	-	-	-	-
149	SCB5/27$_8$II	1	35	23	23	1100	790	490	490	-	-	-	-	-	-
150	SCB 7/24$_4$II	0	20	28	26	24000	16000	1300	16	-	-	-	-	-	-

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	DGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
151	SCB 2/28$_5$II	12	30	18	11	68	45	45	45	-	-	-	-	-	-
152	SCB 3/18$_1$II	13	17	13	11	20	20	20	0	-	-	-	-	-	-
153	SCB 6/11$_2$II	7	39	35	29	330	130	20	45	-	-	-	-	-	-
154	SCB 7/10$_2$II	0	25	27	25	24000	24000	1300	200	-	-	-	-	-	-
155	SCB 8/29$_1$II	9	17	27	25.5	78	78	0	78	-	-	-	-	-	9
156	SCB 9/12$_2$II	10	5	27	25	220	130	0	20	20	20	230	45	0	6.4
157	SCB 2/28$_2$II	5	45	19	13.5	1300	490	78	220	-	-	-	-	-	-
158	SCB 3/28$_5$II	175	-	19	11	2200	2200	0	2200	-	-	-	-	-	-
159	SCB 4/29$_1$II	17	3	25	21.5	130	0	0	0	-	-	-	-	-	-
H 160	SCB 11/30$_1$II	12	50	9	8.4	3200	3200	3200	50	-	-	-	-	-	-
161	SCB 2/4$_4$II	4	50	0	6.5	24000	24000	810	810	-	-	-	-	-	-
162	SCB 2/4$_9$II	4	50	1	6	24000	24000	720	810	-	-	-	-	-	-
163	SCB 3/28$_1$II	10	-	12	13	460	460	20	68	-	-	-	-	-	-
164	SCB 3/28$_6$II	15	-	22	16	490	220	20	220	-	-	-	-	-	-
165	SCB 4/15$_5$II	15	15	20	22	230	130	0	45	-	-	-	-	-	-
166	SCB 5/13$_1$II	9	-	26	27	490	330	0	45	-	-	-	-	-	-
167	SCB 5/13$_2$II	4	-	24	24	210	210	20	40	-	-	-	-	-	-
168	SCB 5/27$_9$II	20	20	24	25	20	20	0	20	-	-	-	-	-	-
169	SCB 6/11$_1$II	4	40	32	31	490	230	45	78	-	-	-	-	-	-
170	SCB 6/30$_1$II	10	50	23	27	490	330	0	45	-	-	-	-	-	-
171	SCB 7/10$_1$II	8	20	29	31	230	230	0	0	-	-	-	-	-	7.4
172	SCB 7/24$_5$II	12	15	27	29	1700	460	78	0	3400	-	-	-	-	-
173	SCB 8/20$_1$II	4	70	21	22	24000	16000	310	61	1300	1300	-	-	-	5.5
174	SCB 8/29$_5$II	10	10	30	25	5400	470	330	170	45	20	-	-	-	5.3
175	SCB 9/12$_1$II	10	10	27	26	2400	490	20	20	45	45	460	20	TNTC	6.5
176	SCB 10/31$_3$II	19	70	20	17	220	220	45	140	0	0	130	0	100	-
177	SCB 11/15$_1$II	21	18	16	10	3500	3500	120	210	45	20	490	68	0	-
178	SCB 2/4$_7$II	2	46	2	6.5	24000	24000	640	24000	-	-	-	-	-	-
179	SCB 2/28$_1$II	0	30	15	11	230	230	78	230	-	-	-	-	-	-
180	SCB 4/15$_1$II	4	17	22	20	9200	9200	0	5400	-	-	-	-	-	-

APPENDIX I

#	Sta	S	Tur	At	Wt	I.c	BGB	EC	EHB	Asp	Act	AZD	EVA	Vib	D.O
181	SCB 4/29$_{1}$II	4	8	25	23.5	330	330	130	130	-	-	-	-	-	-
182	SCB 6/30$_{1}$II	7	50	23	26	24000	24000	1300	410	-	-	-	-	-	-
183	SCB 7/24$_{6}$II	1	50	29	27	24000	4300	230	0	2400	-	-	-	-	-
184	SCB 8/20$_{2}$II	1	100	21	22	24000	24000	430	210	3500	1300	-	-	-	5.4
185	SCB 9/25$_{1}$II	1	-	27	21	16000	16000	3500	16000	0	0	230	78	1	-
186	SCB 10/12$_{2}$II	10	-	25	20	16000	9200	790	470	92	0	330	330	47	-
187	SCB 2/4$_{6}$II	0	22	1	5	24000	24000	720	810	-	-	-	-	-	-
188	SCB 4/15$_{1}$II	4	12	19	18	2200	950	0	640	-	-	-	-	-	-
189	SCB 6/30$_{5}$II	0	60	26	23	5400	5400	1300	2400	-	-	-	-	-	-
G 200	SCB 2/28$_{4}$II	12	30	19	12	130	45	20	45	-	-	-	-	-	-
201	SCB 2/28$_{3}$II	0	20	18	11	270	170	20	110	-	-	-	-	-	-
202	SCB 3/28$_{1}$II	10	-	12	13	460	460	20	68	-	-	-	-	-	-
203	SCB 4/29$_{2}$II	19	8	25	21	1700	1700	1700	0	-	-	-	-	-	-
204	SCB 6/30$_{2}$II	10	35	23	26.5	640	210	20	20	-	-	-	-	-	-
205	SCB 12/7$_{1}$II	22	35	14	8.5	0	0	0	0	0	0	0	0	0	15
I 206	SCB 9/12$_{1}$III	11	10	26	26	220	45	0	45	0	0	230	20	+	6.9
207	SCB 12/7$_{6}$ III	22	12	13.5	9	20	20	0	0	0	0	230	0	0	17
208	SCB 11/30$_{2}$III	22	-	8.8	9	33	17	8	11	-	-	-	-	-	-
209	SCB 3/28$_{1}$III	21	-	13	12.5	78	78	0	78	-	-	-	-	-	-
210	SCB 3/28$_{8}$III	19	-	18	11.5	0	0	0	0	-	-	-	-	-	-
211	SCB 4/29$_{1}$III	20	0	25	22	78	0	0	0	-	-	-	-	-	-
212	SCB 6/30$_{1}$III	12	25	22.5	26	170	45	20	20	-	-	-	-	-	-
213	SCB 2/4$_{1}$III	0	88	-1.5	4	24000	24000	320	24000	-	-	-	-	-	-
214	SCB 5/13$_{1}$III	0	-	26	25	460	68	0	20	-	-	-	-	-	-
215	SCB 7/24$_{1}$III	0	20	27	27	9200	9200	790	68	-	-	-	-	-	-
216	SCB 3/20$_{1}$III	0	320	22	22	24000	24000	310	61	3000	3500	-	-	-	4.8
217	SCB 11/30$_{1}$III	-	-	8.5	9	5	2	2	2	-	-	-	-	-	-
218	SCB 2/28$_{3}$III	15	30	16	11	78	45	20	20	-	-	-	-	-	-
219	SCB 2/28$_{5}$III	15	15	18	13	20	0	0	0	-	-	-	-	-	-
220	SCB 3/29$_{7}$III	21.5	-	20	15.5	45	45	18	45	-	-	-	-	-	-

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	DGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
221	SCB 6/30$_{2}$III	11	40	26	26	490	330	0	0	-	-	-	-	-	-
222	SCB 9/12$_{2}$III	115	7	28	26.5	220	170	78	78	18	0	230	0	+	6.2
223	SCB 12/7$_{5}$III	22	10	12.5	8.5	0	0	0	0	0	0	0	0	0	16
224	SCB 2/28$_{2}$III	15	22	15	13	0	0	0	0	-	-	-	-	-	-
225	SCB 2/28$_{6}$III	17	25	18	13	0	0	.0	0	-	-	-	-	-	-
226	SCB 3/28$_{2}$III	18	-	13	12.2	230	130	45	130	-	-	-	-	-	-
227	SCB 4/29$_{2}$III	21	1	26	22	230	0	0	0	-	-	-	-	-	-
228	SCB 9/12$_{3}$III	11	8	27	16	490	220	0	68	230	45	130	20	+/+	6.6
229	SCB 12/7$_{4}$III	25	10	12	8	0	0	0	0	0	0	0	0	0	14
230	SCB 11/30$_{1}$IV	4	75	8.8	9	1600	1600	540	920	-	-	-	-	-	-
231	SCB 2/28$_{8}$IV	14	20	17	14	20	18	.0	18	-	-	-	-	-	-
232	SCB 2/28$_{9}$IV	12	15	16	14	140	45	45	20	-	-	-	-	-	-
233	SCB 3/28$_{1}$IV	10	-	15	13.5	1800	1800	18	1800	-	-	-	-	-	-
234	SCB 4/29$_{1}$IV	20	5	26	22	230	0	0	0	-	-	-	-	-	-
235	SCB 6/30$_{3}$IV	15	35	29	26	950	160	0	0	-	-	-	-	-	-
236	SCB 9/12$_{1}$IV	12	6	27	27	260	110	20	45	230	20	230	45	+/	-
237	SCB 12/7$_{1}$IV	12	6	27	27	260	110	20	45	230	20	230	45	+/	
238	SCB 2/4$_{4}$IV	0	30	-1.5	2	24000	24000	320	320	-	-	-	-	-	-
239	SCB 2/28$_{3}$IV	1	35	11	8.5	460	460	330	330	-	-	-	-	-	-
240	SCB 2/28$_{6}$IV	0	45	20	11	-	-	-	-	-	-	-	-	-	-
241	SCB 4/15$_{1}$IV	0	5	21	18	400	330	0	330	-	-	-	-	-	-
242	SCB 5/13$_{3}$IV	0	-	26	19	2200	2200	110	110	-	-	-	-	-	-
243	SCB 6/30$_{2}$IV	0	45	35	21	5400	2200	230	700	-	-	-	-	-	-
244	SCB 7/24$_{1}$IV	0	70	28	24	2800	950	330	230	410	-	-	-	-	-
245	SCB 8/20$_{4}$IV	0	210	22	22	24000	24000	580	140	2400	2400	-	-	-	5.4
246	SCB 9/12$_{2}$IV	1	12	30	21	9200	3500	330	460	2400	110	330	330	0	-
247	SCB 9/25$_{4}$IV	0	-	27	13.5	2400	2400	2400	2400	0	-	3500	1300	0	7
248	SCB 10/12$_{1}$IV	0	-	16	24	1200	1200	330	950	18	0	3000	470	0	-
249	SCB 10/31$_{1}$IV	1	100	21	16	3500	240	230	240	0	0	3500	3500	0	-
250	SCB 11/15$_{3}$IV	0	28	15	10	3500	1300	1300	1300	78	20	2400	220	0	-

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	DCB	EC	EMB	Asp	Act	AZD	FVA	Vib	D.O
251	SCB $2/28_{7}$IV	-	-	15	-	2400	130	45	78	-	-	-	-	-	-
252	SCB $2/28_{10}$IV	6	45	14	16	230	130	45	130	-	-	-	-	-	-
253	SCB $3/28_{2}$IV	4	-	17	12.5	170	170	18	130	-	-	-	-	-	-
254	SCB $2/4_{3}$IV	0	48	-2	3	24000	810	190	320	-	-	-	-	-	-
255	SCB $2/28_{2}$IV	0	60	11	8	110	20	20	20	-	-	-	-	-	-
256	SCB $2/28_{5}$IV	0	55	20	11	230	0	0	0	-	-	-	-	-	-
257	SCB $4/15_{2}$IV	0	5	25	18	1100	1100	0	45	-	-	-	-	-	-
258	SCB $5/13_{3}$IV	0	-	26	19	2200	2200	110	110	-	-	-	-	-	-
259	SCB $6/30_{1}$IV	0	55	30	19	640	260	330	170	-	-	-	-	-	-
260	SCB $7/24_{2}$IV	0	-	27	25	2200	1700	490	170	-	-	-	-	-	-
261	SCB $8/20_{3}$IV	0	100	22	22	16000	5400	230	400	18	18	-	-	-	5.4
262	SCB $9/12_{3}$IV	1	10	29	21	3500	1300	78	110	1300	130	700	490	0	-
263	SCB $9/25_{3}$IV	0	-	27	16	330	330	230	230	0	0	460	210	0	7.8
264	SCB $10/12_{2}$IV	0	-	25	16	700	700	140	460	0	0	170	130	0	-
265	SCB $10/31_{2}$IV	1	90	21	17	790	790	170	790	0	0	790	790	0	-
266	SCB $11/15_{2}$IV	0	27	14	11	2400	1300	68	140	0	0	330	110	0	-
267	SCB $2/4_{2}$IV	0	79	-2	3	24000	810	260	320	-	-	-	-	-	-
268	SCB $2/28_{1}$IV	0	35	11	9	20	20	20	20	-	-	-	-	-	-
269	SCB $2/28_{4}$IV	0	30	23	9	45	0	0	0	-	-	-	-	-	-
270	SCB $4/15_{3}$IV	0	2	23	19	9200	2800	0	110	-	-	-	-	-	-
271	SCB $8/20_{2}$IV	0	115	23	22	24000	24000	230	81	68	68	-	-	-	4
272	SCB $9/12_{4}$IV	1	9	31	21	3500	1700	140	170	2100	45	1800	170	0	-
273	SCB $9/25_{2}$IV	0	-	28	16	330	330	45	110	0	0	330	170	0	7.2
274	SCB $10/12_{3}$IV	0	-	24	16.5	490	330	230	170	0	0	120	61	2	-
275	SCB $10/31_{3}$IV	0	30	22	16	230	230	78	130	0	0	330	330	0	-
276	SCB $11/15_{1}$IV	1	18	16	11	3500	790	110	170	0	0	130	130	0	-
277	SCB $2/4_{1}$IV	0	92	-2	1.5	810	810	210	320	-	-	-	-	-	-
278	SCB $4/15_{4}$IV	0	10	22	14	9200	5400	0	280	-	-	-	-	-	-
279	SCB $8/20_{1}$IV	0	80	23	22	24000	16000	230	68	68	68	-	-	-	5.0
280	SCB $9/25_{1}$IV	2	-	26.5	18	330	230	20	78	0	0	230	0	0	7.5

APPENDIX I

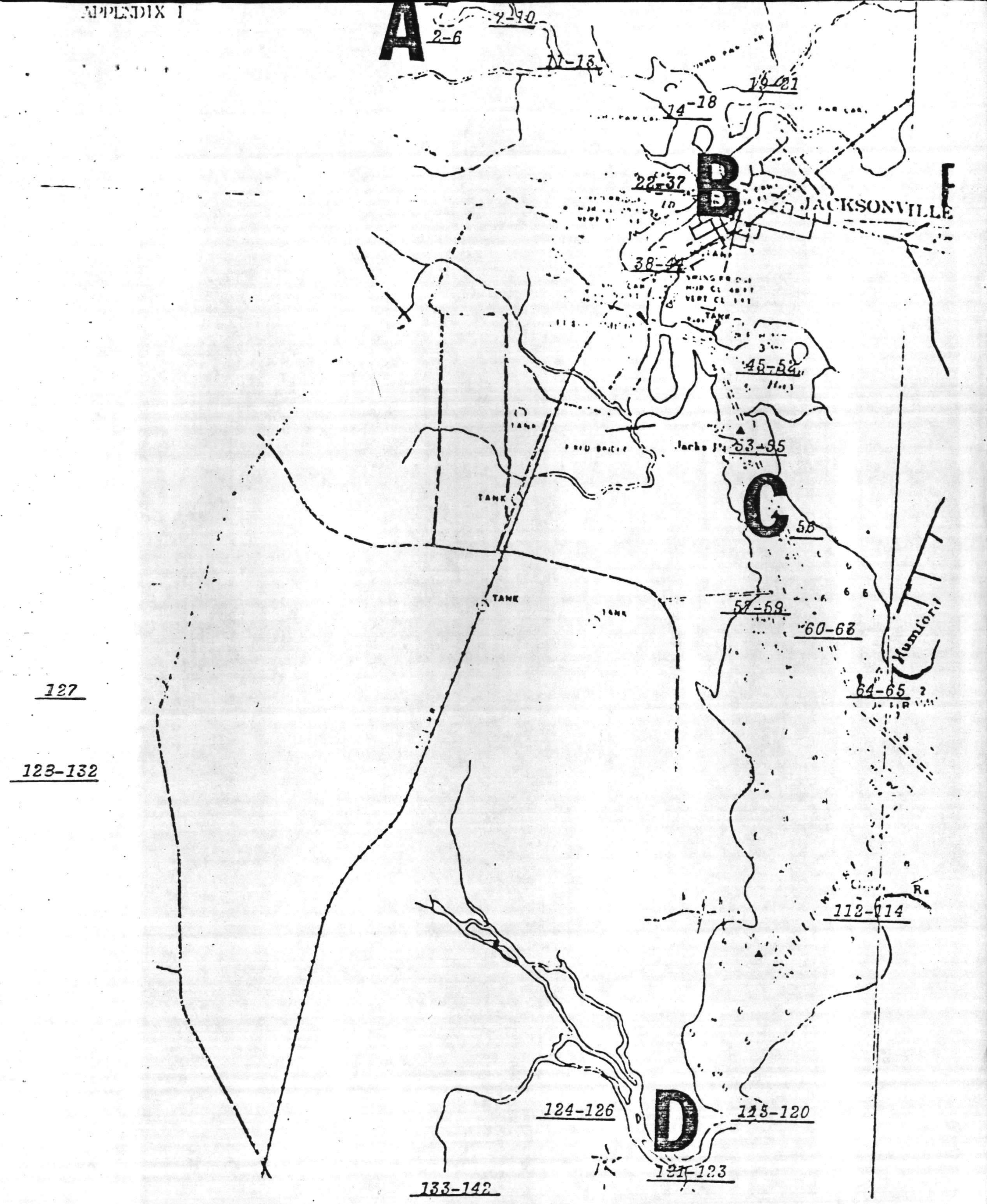
#	Sta	S	Tur	At	Wt	Lt	BGB	EC	ENB	Asp	Act	AZD	EVA	Vib	D.O
J 281	SCB 3/28$_3$III	19	-	17	12	18	18	0	0	-	-	-	-	-	-
282	SCB 3/28$_6$III	23	-	19	11.8	78	78	20	78	-	-	-	-	-	-
283	SCB 4/29$_3$III	21	10	26	22	170	18	18	0	-	-	-	-	-	-
284	SCB 9/12$_4$III	13	8	28	26	280	78	0	20	0	0	78	0	+/	-
285	SCB 12/7$_3$III	27	10	12	8.5	0	0	0	0	0	0	0	0	0	15
286	SCB 4/29$_4$III	25	5	26	22	170	18	18	0	-	-	-	-	-	-
287	SCB 6/30$_4$III	17	25	29	26.5	45	20	0	0	-	-	-	-	-	-
288	SCB 9/12$_5$III	15	12	27.5	26	0	0	0	0	0	0	78	0	+/	-
289	SCB 3/28$_4$III	21.5	-	18	12	0	0	0	0	-	-	-	-	-	-
290	SCB 3/28$_5$III	24	-	18	12.5	310	310	0	170	-	-	-	-	-	-
291	SCB 6/30$_5$III	20	20	24	26	130	20	0	0	-	-	-	-	-	-
292	SCB 9/12$_6$III	17	7	27	26	78	0	0	0	0	0	45	0	+/+	-
293	SCB 12/7$_2$III	28	10	12	8.5	1400	950	0	700	0	0	0	0	0	7.7
M 294	SCB 2/28$_1$III	18	15	15	-	0	0	0	0	-	-	-	-	-	-
295	SCB 2/28 III	25	10	15	-	20	20	20	20	-	-	-	-	-	-
296	SCB 3/28$_1$III	21	-	13	12.5	78	78	0	78	-	-	-	-	-	-
297	SCB 4/29$_5$III	28	5	17	22	130	0	0	0	-	-	-	-	-	-
298	SCB 9/12$_7$III	16	7	27	26	37	37	0	18	20	0	310	18	+/	-
299	SCB 11/7$_1$III	30	8	14	9	0	0	0	0	0	0	0	0	/	7.5
L 300	SCB 1/17$_1$III	2	-	2	2	270	40	0	18	-	-	-	-	-	-
301	SCB 1/21$_1$III	0	55	10	10	3500	1100	120	61	-	-	-	-	-	-
302	SCB 2/28$_7$III	0	20	22	10	-	-	-	-	-	-	-	-	-	-
303	SCB 4/29$_6$III	0	10	25	20	790	330	0	20	-	-	-	-	-	-
304	SCB 5/27$_1$III	1	70	23	20	1700	490	110	140	-	-	-	-	-	-
305	SCB 7/24$_2$III	0	50	30	27	1500	950	330	210	-	-	-	-	-	-
306	SCB 10/12$_1$III	1	-	25	15	330	230	45	45	40	0	82	18	-	-
307	SCB 11/15$_1$III	0	42	17	10	61	18	0	0	0	0	130	20	-	-
308	SCB 1/17$_7$ V	5	-	2	2	490	490	490	490	-	-	-	-	-	-
309	SCB 1/21$_1$ V	2	50	9	9	2200	790	790	790	-	-	-	-	-	-
310	SCB 4/29$_1$ V	14	5	27	25	790	330	330	170	-	-	-	-	-	-

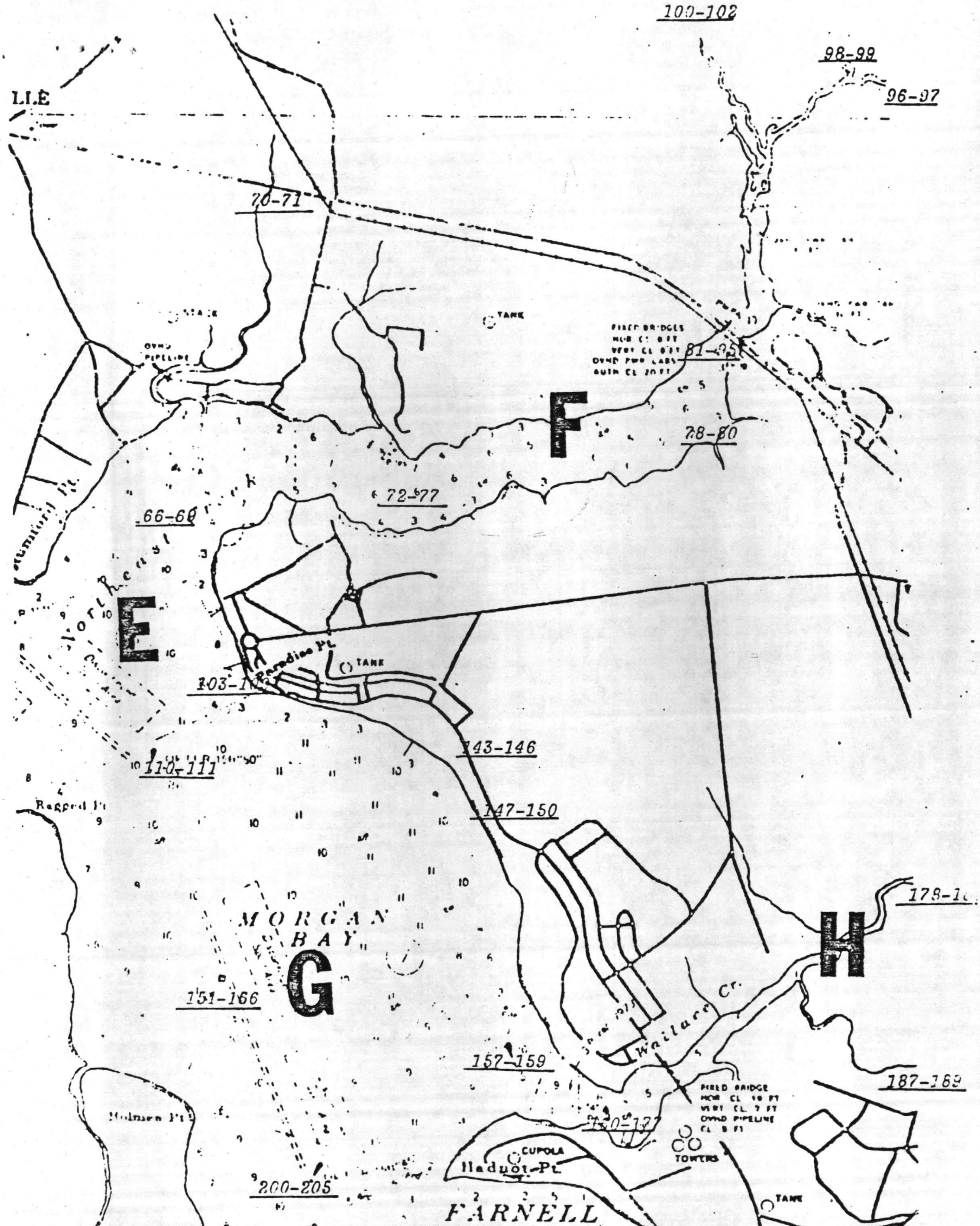
APPENDIX I

#	Sta	[illegible]	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
311	SCB 5/27$_{4}$V	2	90	23	23	790	790	330	220	-	-	-	-	-	-
312	SCB 6/30$_{3}$V	13	40	26	26	24000	9200	110	110	-	-	-	-	-	-
313	SCB 7/24$_{1}$V	11	45	29	28	9200	5400	130	0	490					
314	SCB 8/20$_{1}$V	0	145	23	21	24000	24000	230	240	20	20	-	-	-	-
315	SCB 10/12$_{3}$V	15	-	27	18	9200	9200	460	9200	18	0	440	170	-	-
316	SCB 11/15$_{1}$V	22	29	17	12	24000	5400	490	2200	330	45	490	330	-	-
317	SCB 1/17$_{11}$V	0	-	2	2	330	130	0	20	-	-	-	-	-	-
318	SCB 1/21$_{2}$V	1	65	9	8	1100	460	45	110	-	-	-	-	-	-
319	SCB 5/27$_{5}$V	1	80	23	19	330	330	20	20	-	-	-	-	-	-
320	SCB 7/24$_{2}$V	1	95	28	29	1700	1700	0	82	-	-	-	-	-	-
321	SCB 10/12$_{4}$V	0	-	25	16	3500	2400	78	270	230	130	20	0	-	-
322	SCB 11/15$_{2}$V	0	73	18	12	1800	460	0	210	0	0	490	0	-	-
323	SCB 1/17$_{9}$V	0	-	2	2	110	20	0	0	-	-	-	-	-	-
324	SCB 1/21$_{4}$V	0	65	9	9	130	130	45	20	-	-	-	-	-	-
325	SCB 7/24$_{3}$V	0	90	30	29	2200	470	20	20	-	-	-	-	-	-
326	SCB 1/17$_{8}$V	0	-	2	2	270	220	45	93	-	-	-	-	-	-
327	SCB 1/21$_{5}$V	0	45	9	9	230	230	130	45	-	-	-	-	-	-
328	SCB 5/27$_{3}$V	1	70	24.5	20	700	330	110	170	-	-	-	-	-	-
329	SCB 7/24$_{4}$V	0	55	30	29	5400	3500	20	130	-	-	-	-	-	-
M 330	SCB 1/17$_{10}$V	14	-	2	2	1100	180	0	180	-	-	-	-	-	-
331	SCB 1/21$_{8}$V	9	30	9	9	3500	790	130	220	-	-	-	-	-	-
332	SCB 5/27$_{6}$V	21	40	24	23	490	490	40	330	-	-	-	-	-	-
333	SCB 3/28$_{2}$V	24.5	-	16	12	310	310	0	170	-	-	-	-	-	-
334	SCB 6/30$_{2}$V	21	20	26	26	78	20	0	0	-	-	-	-	-	-
335	SCB 9/12$_{2}$V	16	8	29	26	20	20	0	0	0	0	20	0	+/	-
336	SCB 1/17$_{2}$V	21	-	2	2	790	270	0	110	-	-	-	-	-	-
337	SCB 1/17$_{3}$V	19	-	2	2	45	45	20	20	-	-	-	-	-	-
338	SCB 5/27$_{2}$V	28	90	24	24	45	20	0	20	-	-	-	-	-	-
339	SCB 6/30$_{1}$V	14	30	28	26	130	0	0	0	-	-	-	-	-	-
340	SCB 9/12$_{1}$V	16	5	28.5	26	55	55	0	0	0	0	20	0	0	-

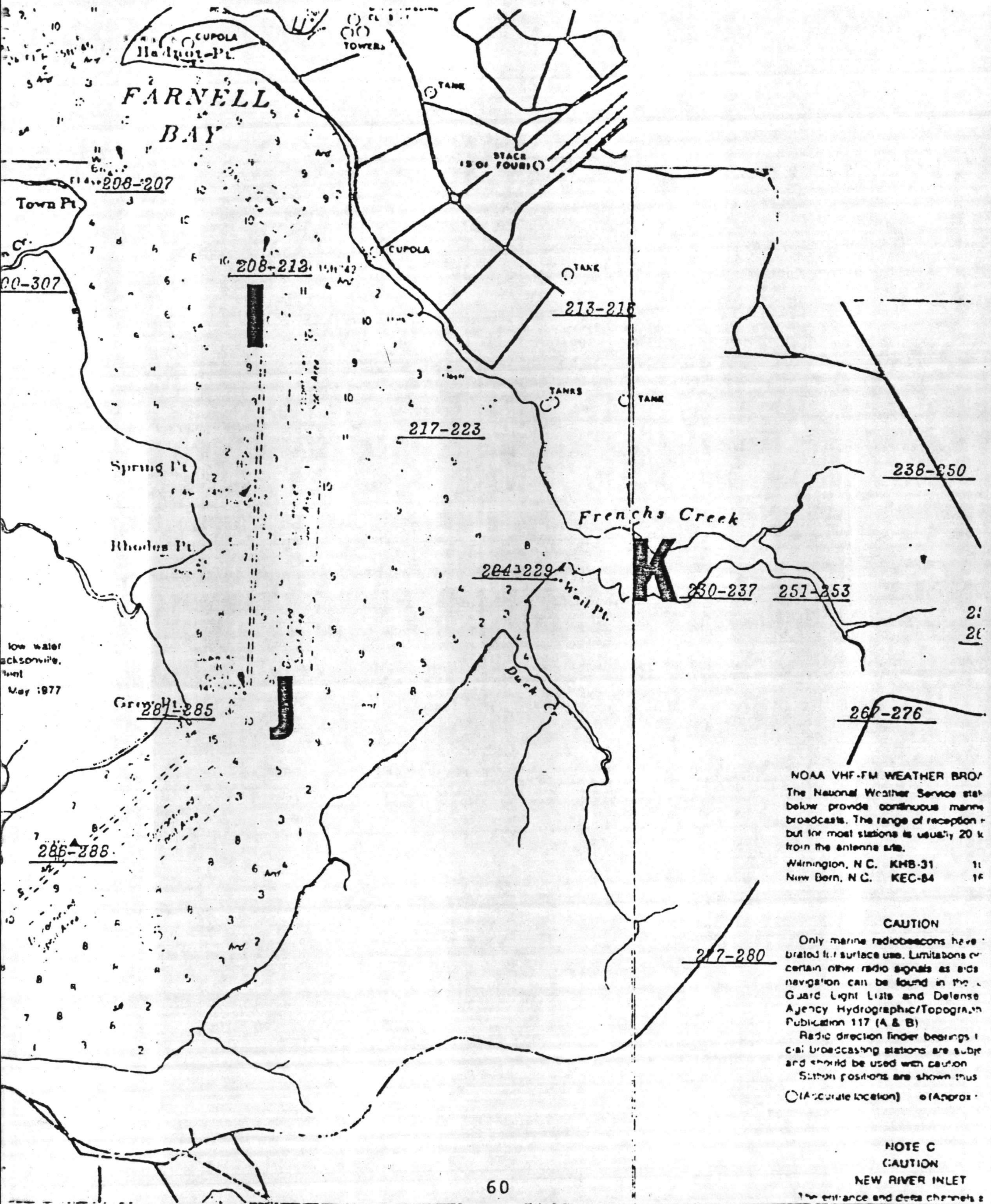
APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	P.O
341	SCB 1/17$_{1}$V	0	-	-2	0	490	330	220	330	-	-	-	-	-	-
342	SCB 2/28$_{2}$V	0	40	21	13	330	330	330	45	-	-	-	-	-	-
343	SCB 5/27$_{1}$V	8	80	24	25	3500	1700	330	130	-	-	-	-	-	-
344	SCB 7/24$_{6}$V	5	70	30	28	2400	1300	1300	0	230	-	-	-	-	-
345	SCB 10/12$_{2}$V	19	-	27	19.5	3500	3500	1300	3500	0	-	5400	1300	-	-
346	SCB 10/31$_{2}$V	10	175	18	17.5	700	700	230	700	20	20	1300	230	91/1	-
347	SCB 1/17$_{4}$V	-	-	2.5	.8	400	210	120	82	-	-	-	-	-	-
348	SCB 1/21$_{6}$V	0	55	12	7	3500	1700	700	1400	-	-	-	-	-	-
349	SCB 4/29$_{2}$V	2	1	27	20.5	1300	1300	45	45	-	-	-	-	-	-
350	SCB 5/27$_{8}$V	1	70	24.5	20	700	330	110	170	-	-	-	-	-	-
351	SCB 6/30$_{4}$V	0	120	26	19	16000	540	140	240	-	-	-	-	-	-
352	SCB 7/24$_{5}$V	0	105	30	27	1800	1800	0	61	-	-	-	-	-	-
353	SCB 10/12$_{1}$V	1	-	27	15	9200	1700	490	1700	110	0	490	140	5/	-
354	SCB 10/31$_{1}$V	0	55	19	14	2800	2800	2800	2800	0	0	16000	16000	0	-
355	SCB 11/15$_{3}$V	5	57	17	11	24000	2800	490	3500	120	20	3500	3500	0	-
356	SCB 1/17$_{1}$VII	23	18	-2.8	.2	0	0	0	0	-	-	-	-	-	-
357	SCB 3/28$_{1}$VII	23.5	-	18	12.5	0	0	0	0	-	-	-	-	-	-
358	SCB 4/29$_{1}$VII	29	1	27	22	230	0	0	0	-	-	-	-	-	-
359	SCB 6/30$_{1}$VII	20	30	28	-	330	20	0	0	-	-	-	-	-	-
360	SCB 8/20$_{1}$VII	16	190	24	22	24000	24000	310	55	24000	3500	-	-	-	6.6
361	SCB 9/25$_{1}$VII	22	-	27	21	20	0	0	0	0	0	230	0	.57/1	-
362	SCB 10/12$_{1}$VII	24	-	25	17.5	490	330	0	68	0	0	91	45	157/5	7.5
363	SCB 10/31$_{1}$VII	38	40	22	17	130	0	0	0	0	0	230	20	106/2	-
364	SCB 11/15$_{1}$VII	30	13	15	10	790	330	45	110	0	0	20	0	47/	-
365	SCB 12/7$_{1}$VII	31	10	14	8.5	0	0	0	0	0	0	0	0	0	7.0
366	SCB 9/12$_{1}$VII	20	2	27.5	25.5	20	.0	0	0	0	0	230	0	[illegible]/	-


A
2-6
7-10
11-13
14-18
19-21
B
22-37
JACKSONVILLE
E
38-44
45-52
TANK
53-55
C
56
57-59
60-63
Rumford
64-65
112-114
127
128-132
124-126
D
115-120
121-123
133-142



100-102
98-99
96-97
LLE
70-71
TANK
FIXED BRIDGES
81-95
78-80
72-77
66-69
Northeast
E
F
Paradise Pt
TANK
103-10
143-146
110-111
Ragged Pt
147-150
178-1
MORGAN
BAY
G
H
151-166
Wallace Cr
157-159
187-189
FIXED BRIDGE
HOR CL 10 FT
VERT CL 7 FT
OVHD PIPELINE
CL 8 FT
170-177
TOWERS
CUPOLA
Holmes Pt
Hadnot Pt
200-205
TANK
FARNELL



NOAA VHF-FM WEATHER BRO

The National Weather Service sta below provide continuous marine broadcasts. The range of reception but for most stations is usually 20 k from the antenna site.

Wilmington, N.C.	KHB-31	1
New Bern, N.C.	KEC-84	1

CAUTION

Only marine radiobeacons have brated for surface use. Limitations o certain other radio signals as aids navigation can be found in the Guard Light Lists and Defense Agency Hydrographic/Topograph Publication 117 (A & B)

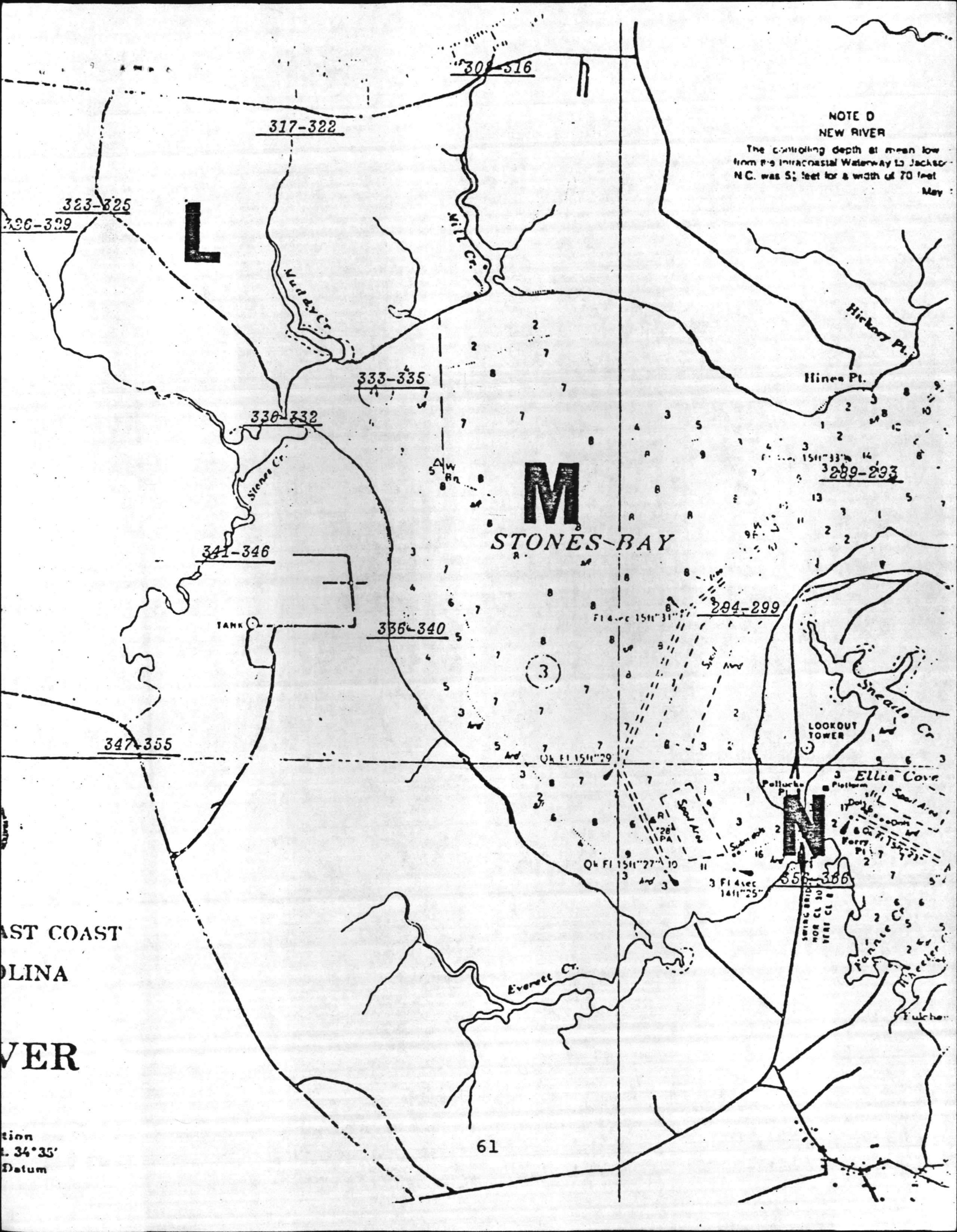
Radio direction finder bearings cial broadcasting stations are subje and should be used with caution.

Station positions are shown thus

◯(Accurate location) ○(Approx

NOTE C
CAUTION
NEW RIVER INLET

The entrance and delta channels a



NOTE D
NEW RIVER
The controlling depth at mean low ... from the Intracoastal Waterway to Jackso... N.C. was 5½ feet for a width of 70 feet ... May
L
M
N
STONES BAY
Mill Cr.
Muddy Cr.
Stones Cr.
Hickory Pt.
Hines Pt.
Everett Cr.
Sneads Cr.
Ellis Cove
LOOKOUT TOWER
TANK
Ferry Pt.
308-316
317-322
323-325
326-329
330-332
333-335
336-340
341-346
347-355
356-366
289-293
294-299
AST COAST
OLINA
VER

APPENDIX II

Suppliers

Sigma Chemical Co.	- DL-asparagine (pfs) acetamide (pfs) phenol red acid free
Fisher Scientific Co.	- phosphate buffer (pH 7.2) potassium phosphate dibasic potassium phosphate monobasic polyethylene gloves borosilicate glass culture tubes, 18 X 150 borosilicate glass bottles, 250 ml Azide Dextrose Broth Ethyl Violet Azide Broth TCBS agar microscope slide labels 6" cotton-tipped applicators
American Scientific Co.	-Bacto-agar Lauryl Tryptose broth thermometers EC media Brilliant Green Bile Broth 2% Eosin Methylene Blue agar American Optical refractometer
International Products	- "MICRO" glassware soap
Hach Chemical Co.	- Direct Reading Engineers Laboartory DR-EL/4
YSI Scientific	- field oxygen meter model 57

University of North Carolina
at Wilmington
28406

APPENDIX 3 - NEW RIVER STUDY QUESTIONNAIRE
COVER LETTER

A study of the New River estuary has been conducted by the University of North Carolina at Wilmington over the past two years. One of the project goals is to increase fishing and other recreational usage of the estuary. However, we need to ascertain the present level of such usage, information that can be supplied by such users as yourself. We would greatly appreciate your taking a few minutes to complete the enclosed questionnaire. Because responses will be computerized, individual replies will not be identified. Personal comments are welcome in addition to the survey questions.

For your convenience, a stamped return envelope is enclosed. Thank you for your participation.

Sincerely,

G. Bane

Gilbert W. Bane, Ph.D.
Director, Environmental Studies
Principal Investigator

NATURAL RESOURCES AND ENVIRONMENTAL AFFAIRS DIVISION
BASE MAINTENANCE DEPARTMENT
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA 28542

7-6-81

From: Director, NREA Division
To: Danny
Subj:

1. Dr B [illegible] sent this to me

Julian

Please Review and Comment at your leisure unless otherwise advised

Danny Sharpe

THE POLLUTION-RELATED MICROBIOLOGY

OF THE

NEW RIVER ESTUARY

A Report Prepared for the City of Jacksonville,
Onslow County Planning Department
and
North Carolina Coastal Zone Management Program
19 June 1981

By: Gilbert W. Bane, Ph.D.
Principal Investigator
University of North Carolina
at Wilmington

&

Catherine Roznowski
Project Director
University of North Carolina
at Wilmington

TABLE OF CONTENTS

INTRODUCTION

The New River Estuary is located in Onslow County, N. C., bordered on the north by Jones County, Duplin County to the west, and Carteret County and Onslow Bay on the east. The county has a surface area of 806 square miles, of which 50 square miles is water.

Planners in Onslow County and Jacksonville are presently concerned with the water quality of the New River and its adjacent estuary because of the present and potential use of these waters for recreational boating, swimming, and commercial and recreational finfishing and shellfishing. The proximity to regional estuaries of sewage disposal systems, the influence of water runoff from adjacent land areas, and discharges from storm drains and other outflows, has added to the burden of the bay as a bacteriological sink. Because these waters lie within the urban region dominated by the Camp Lejeune Marine Base, the City of Jacksonville and several other coastal communities concern for water quality has risen sharply.

Of major importance in the evaluation of water quality is the study of coliform bacteria extant in these water systems. As defined by the American Public Health Association (1975), the coliform group comprises bacteria that are aerobic or facultative anaerobic, gram negative, non-spore forming and rod-shaped, fermenting lactose with gas formation within 48 hours at 35^{o}C. Fecal coliform bacteria are found in the fecal matter of all animals, including humans, and are usually introduced into the

water column through septic tank seepage, sewage outfalls, and land runoff. By APHA definition, fecal coliform are those that ferment lactose with gas formation in a suitable culture medium in 24 hours at 44.5°C.

The importance of fecal coliform bacteria in water quality study lies in their usefulness as an indicator organism for many pathogenic microorganisms (Lyne and Collins, 1970; Wyss and Eklund, 1971; American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 1971; Wheeler and Volk, 1964). Table 1 lists pathogenic organisms in the United States for which the coliform bacteria, *Escherichia coli* is an indicator.

The detection of coliform bacteria, specifically in the *Escherichia, Enterobacter, Shigella* and *Salmonella* groups, is not a statement of pathogenicity within the water tested, but serves as a warning signal of their presence (Peleczar and Reid, 1972). It is also the accepted standard for water and shellfish suitability of the U. S. Food and Drug Administration.

Despite significant advancements in the fields of medicine and sanitation, fecal coliform groups continue to create health problems, largely attributable to increased urbanization and the increasing use of internal medicines. Increased urbanization invariably results in expanded sewage outflow, most commonly into septic tank systems that drain into adjacent lands. The use of internal medicines in relation to the waste disposal problem was addressed in 1971 by Martin Alexander in his book <u>Microbial Ecology</u>: "Antibiotics inhibiting the normal intestinal bacteria sometimes allow for the proliferation of strains of *Staphlococcus*,

water colo [illegible]
land runo [illegible]
ferment [illegible]
in 24 hou [illegible]

The [illegible]
study li [illegible]
many patho [illegible]
and Ekl [illegible]
Water Work [illegible]
1971; Wh [illegible]
is the be [illegible]
coli is no [illegible]

The [illegible]
Escherichia [illegible]
not a stat [illegible]
serves as a [illegible]
Reid, 1972 [illegible]
shellfish o [illegible]

Despite [illegible]
and sanitar [illegible]
problems. Th [illegible]
increasing [illegible]
invariably [illegible]
septic tank [illegible]
internal medi [illegible]
addressed in [illegible]
Ecology: [illegible]
sometimes allow [illegible]

TABLE 1

Pathogenic Organisms for which *Escherichia coli* is an indicator.

The following organisms have been in epidemic proportion in the U. S. (1946-1975) (Brock, 1979).

	ORGANISM	DISEASE
Bacteria		
	Salmonella typhi	Typhoid Fever
	Vibrio cholerae	Cholerea
	Shigella sp.	Shigellosis
	Salmonella paratyphi	Salmonellosis
	Escherichia coli (pathogenic strains)	Gastroenteritis
	Leptospira sp.	Leptospirosis
	Francescilla tularensis	Tularemia
Viral	Hepatitis A Virus	Infectious hepatitis
	Polio Virus	Poliomyelitis

Proteus, and *Pseudomonas*, microorganisms that would not have been prominent in the absence of the chemical; such organisms in turn cause infections that probably would not have been evident in untreated patients" (p. 219).

When wastes from sewage and septic systems, as well as storm drain discharge and animal waste from farmlands, runoff, enter waters intended for uses other than waste disposal, care must be taken to prevent excessive coliform loads from threatening public health and safety.

In the New River area, concern for contamination has been focused on the decline of shellfish productivity in several areas. A heavy coliform burden has led to enforced closure of many large oyster beds in the estuary and loss of income to local oystermen.

The Stones Bay area of the New River estuary is monitored by the N. C. Shellfish Sanitation Program, Department of Health Services, which is responsible for the sanitary quality of the shellfish beds located in the bay. The opening and closure of oyster beds for reasons of public health, is mandated through this program. The New River is presently closed to shellfishing from Gray's point to the headwaters. It is closed in Stones Bay from Mill Creek south along the western bank to marker 29, and all of Everett Creek. In 1979, the N. C. Department of Natural Resources and Community Development, Division of Marine Fisheries, planted 14,900 bushels of oysters in Stones Bay. Coliform levels in these organisms are routinely monitored by the Shellfish Sanitation Program.

On April 15, 1981, a forest fire destroyed 20,000 acres of the New River watershed. The damage, in terms of lost watershed,

cannot be assessed at present, but may add to the already considerable biological burden of the river system. Additional monitoring of the area will be needed before such impact can be determined.

Mindful of the importance of coliform bacteria, the Onslow County Planning Department has assumed the responsibility for assessing regional water quality. Its objectives are to develop a system to abate the high coliform bacteria levels which presently occur in the river and estuary, to determine specific source of coliform bacteria, and to assess seasonal changes in the abundance and distribution of these bacteria throughout the area. Resultant information will be utilized in the decision-making processes affecting land use, recreational and commercial utilization of coastal waters and planning for industrial, residential and other uses of Jacksonville and southern Onslow County.

In accordance with these objectives, Onslow County, the City of Jacksonville and North Carolina Coastal Zone Management have jointly funded the bacteriological analysis of the New River Estuary. The goals of this study are:

1) To assess the coliform and fecal coliform distribution in the waters of the New River adjacent to the City of Jacksonville and around the shores of the Camp Lejeune Marine Base.

2) To define point and non-point sources of pollution in the estuary as they exist.

3) To demonstrate seasonal-geographic changes in coliform counts in the New River Estuary as an indicator of pollution.

4) To present information of the socio-economic consequences of coliform pollution to the residents of Onslow County.

5) To evaluate and define appropriate alternatives to the present discharge systems.

METHODS & MATERIALS

A total of 187 bacteriological samples from 53 field stations was collected between November 30, 1980 and May 27, 1981. The sampling field was the region of the New River Estuary between Stones Bay and the River above Jacksonville.

FIELD COLLECTIONS

Water for analysis was collected in presterlized 200 ml borosilicate glass bottles, submerged a few inches below the surface with the mouth facing upstream. Twenty-five mls of air were retained at the top of each bottle when capped. The samples were stored on ice during transit to the laboratory. For maximum accuracy, no more than six hours elapsed from collection time to lab processing. While in the field, salinity was determined with a hand-held refractometer; water and air temperatures were recorded with a mercury thermometer; a portable field spectrophotometer was used for turbidity reading. Rainfall was obtained from Tru-check rainfall gauges, and at the Environmental Center at Camp Lejeune Marine Base and the Camp Lejeune Air Station.

LABORATORY ANALYSIS

A 1980 incidental study of six critical ions in UNC-W's distilled water supply by the Wilmington, N. C. firm of Law and Company, consulting and analytical chemists, indicated that the

zinc content of the distilled water supply used for bacteriological analyses was sufficiently high to require redistillation. Results of this study are shown as Appendix I. Zinc content after redistillation was .001 PPM.

The "Multiple-Tube Fermentation Technique for Members of the Coliform Group" from Standard Methods for the Examination of Water and Wastewater was followed, comprised of two parts:

1) The Standard Methods technique for total coliform determination:
   a) Presumptive test
   b) Confirmed test
   c) Completed test

2) The Standard Method technique for fecal coliform determination:
   a) Presumptive test
   b) Confirmed test
   c) Fecal coliform test

Each test produces a value, the Most Probable Number (MPN), which is not an actual enumeration of the coliform bacteria, but merely an index of the number of coliform bacteria that, more probably than any other number, would give the results shown by the laboratory examination.

The MPN is a theoretical value interpreted from a table in Microbiological Methods for Monitoring the Environment: Water and Wastes (1978).

zinc content [illegible]

logical [illegible]

Results [illegible]

after [illegible]

Th[illegible]

the Colif[illegible]

Water and [illegible]

[illegible]

In [illegible]

which [illegible]

merely [illegible]

probably [illegible]

the [illegible]

[illegible]

in [illegible]

Water and [illegible]

PRESUMPTIVE TEST

Upon returning to the lab, 1 ml of liquid from each sample was placed into each of 5 test tubes containing double strength lauryl tryptose.[1] Another 1 ml of sample was placed in 9 ml of phosphate buffer, to make a 0.1 dilution; 1 ml of the 0.1 dilution is used to innoculate each of 5 test tubes containing single-strength lauryl tryptose. One ml of the 0.1 dilution is placed in another 9 ml of buffer, making a 0.01 dilution; 1 ml of the 0.01 dilution is used to innoculate each of 5 test tubes of single-strength lauryl tryptose.

An inverted Durham tube was placed in each test tube to concentrate gases and indicate positive or negative results. A positive presumptive test shows gas formation after incubation of 24 $\pm$ 2 hr. or 48 $\pm$ 3 hr. at 35 $\pm$ 0.5^{o}C.

CONFIRMED & FECAL COLIFORM TEST

Each positive presumptive test tube is used to innoculate an EC Medium and a 2% Brilliant Green Bile Broth (BGB), performed with a sterile wooden swab submerged and swirled once around the lauryl tryptose tube, once around the EC tube and finally once around the BGB. The EC Medium is incubated in a water bath at 44.5 $\pm$ 0.2^{o}C for 24 $\pm$ 2 hr. A positive reaction for fecal coliform

---

[1] Due to lab error, stated bacteria counts are lower than they would actually be.

PRESUMPTIVE [illegible]

Upon [illegible] sample
was placed [illegible]
lauryl tryptose [illegible]
phosphate [illegible]
dilution [illegible]
single-strength [illegible]
placed in [illegible]
of the [illegible]
of single-strength [illegible]

An [illegible]
concentrate [illegible]
A positive presumptive [illegible]
of 24 ± 2 h [illegible] 48 [illegible]

CONFIRMED & [illegible]

Each [illegible]
an EC [illegible]
with [illegible]
lauryl tryptose [illegible]
around [illegible]
44.5 ± 0.2 [illegible] form

[1] [illegible]

is indicated by gas formation in the inverted Durham tube after incubation.

The BGB tubes are incubated at 35 ± 0.5°C for 24 ± 2 hr. or 48 ± 3 hr. The formation of gas in an inverted Durham tube indicates a positive test for coliform bacteria.

COMPLETED TEST

The positive confirmed tubes are innoculated onto Eosin Methylene Blue (EMB) agar plates; EMB is a medium that cultures only gram-negative rods. The plates are incubated at 35 ± 0.5°C for 24 ± 2 hr. and can be used to identify specific organisms: *Escherichia coli* has a dark metallic green sheen; *Enterobacter aerogens* produces a colony with a dark nucleus but no metallic green sheen; *Klebsiella* sp. is a large pink mucoid colony; and *Proteus* sp. is a spreading pink colony with a foul odor. A positive EMB test produces *E. coli* or *Enterobacter aerogens*. *Klebsiella* and *Proteus* are classified as negative.

RESULTS

All data for the bacteriological study of the New River are compiled as Figures 1-24 and Tables 2-6. Figures 1-4 and Tables 2-5 show the data from the laboratory analyses. Figures 5-18 are graphs of the MPN at stations around the estuary from November 1980 through May 1981.

Four distinct geographic zones were identified in the New River: the West bank of the River, the Northeast bank, the Southeast bank and a mediating center zone. The coliform counts among these zones correspond to seasonal changes in the bacterial population.

Rainfall, average salinity, and average turbidity in 5 areas of the estuary, also taken during this period, are shown in Figures 19-23. No turbidity measurements were made on January 17, March 28 or May 13. Table 6 shows the rainfall data obtained from the Camp Lejeune Air Station Weather Service, depicted in graphic form on Figure 24.

No statistical correlation was found between salinity and either the average total coliform (R=-0.65 to 0.61, df=3) or fecal coliform numbers (R=-0.65 to 0.61, df=3). The same held true for the turbidity analysis (R=-0.64 to 0.62, df=3). Rainfall data show a strong correlation between amount of rain and to the average total coliform (R=0.65, df=10) and fecal coliform numbers (R=0.61, df=10).

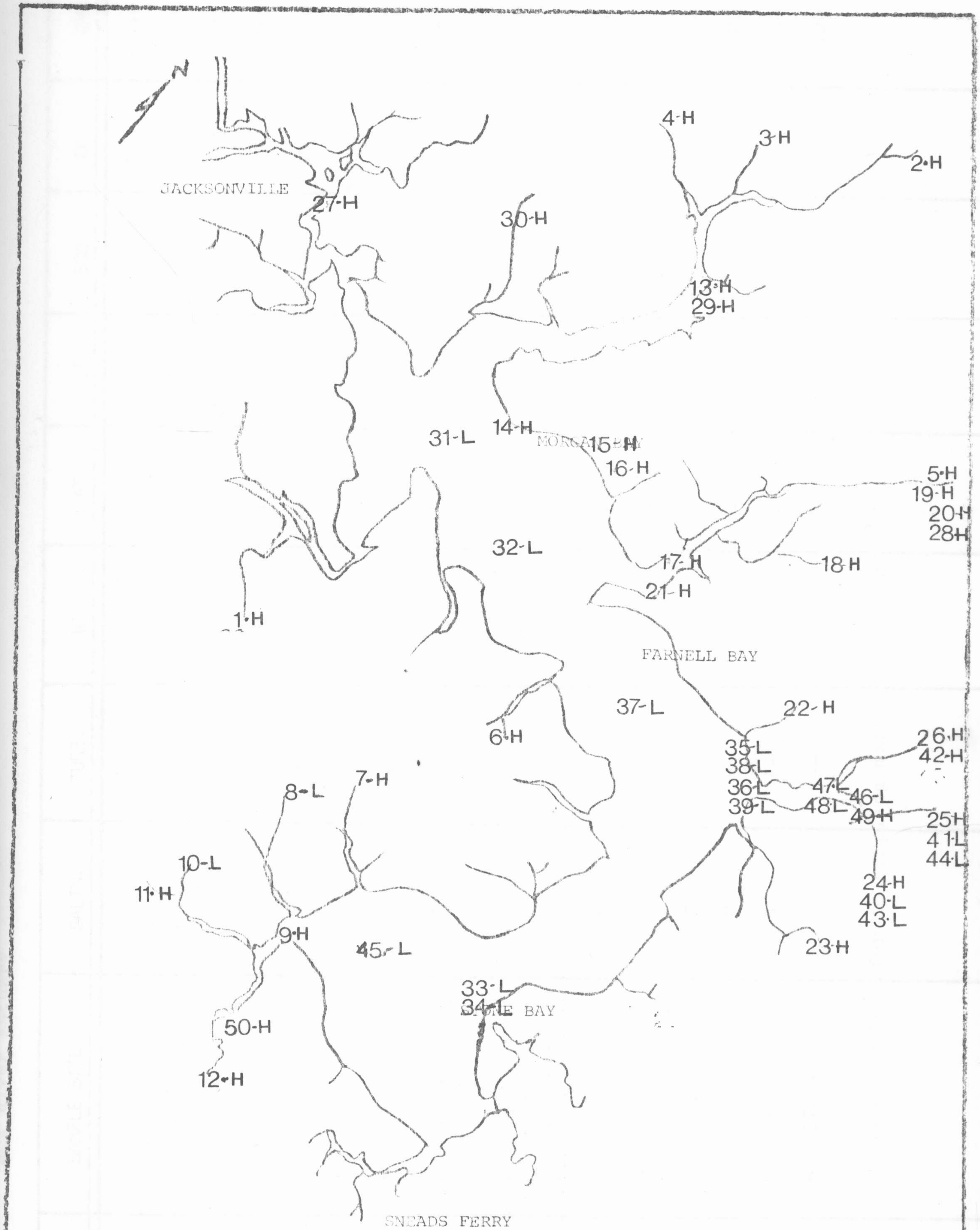


FIGURE 1. SAMPLING STATIONS - NEW RIVER ESTUARY
NOVEMBER 30, 1980 - JANUARY 17, 1981

Table 2. Summary of data from November 30, 1980 to January 17, 1981
New River Estuary

NO.	SAMPLE SITE	SALIN.	TURB.	WT	AT	LT	BGB	EC	EMB
1	SCB $11/30_1$ I*	0	45	9.5	0.5	<2400	920	170	540
2	SCB $11/30_2$ I	0	18	7.6	0.8	<2400	<2400	920	29
3	SCB $11/30_3$ I	2	55	-8.6	2.2	<2400	<2400	540	52
4	SCB $11/30_4$ I	7	50	8.8	6.7	350	280	130	280
5	SCB $11/30_5$ I	5	45	6.2	8.4	1600	1600	350	920
6	SCB $11/30_1$ II	12	50	8.4	9	<2400	<2400	<2400	50
7	SCB $11/30_1$ III	--	--	9	8.5	5	2	2	2
8	SB $11/30_2$ III	22	--	9	8.8	33	17	8	11
9	SB $11/30_1$ IV	4	75	9	8.8	1600	1600	540	920
10	SB $1/17_1$ I	0	--	2	2	1700	220	170	170
11	SB $1/17_1$ III	2	--	2	2	270	40	0	18
12	SB $1/17_1$ V	0	--	0	2	490	330	230	330
13	SB $1/17_2$ V	21	--	2	2	790	270	0	110
14	SB $1/17_4$ V	--	--	0.8	2.5	400	210	120	82
15	SB $1/17_3$ V	19	--	2	2	45	45	20	20
16	SB $1/17_{10}$ V	14	--	2	2	1100	180	0	180
17	SB $1/17_7$ V	5	--	2	2	490	490	490	490

*Roman numerals refer to sampling maps. See Appendix II.

NO.	SAMPLE SITE	SALIN.	TURB.	WT	AT	LT	BGB	EC	EMB

Table 2 (continued)

NO.	SAMPLE SITE	SALIN.	TURB.	WT	AT	LT	BGB	EC	EMB
18	SB $1/17_{11}$ V	0	--	2	2	330	130	0	20
19	SB $1/17_{9}$ V	0	--	2	2	110	20	0	0
20	SB $1/17_{8}$ V	0	--	2	2	270	220	45	93
21	SCB $1/17_{1}$ VII	23	18	2	-2.8	0	0	0	0
22	SCB $1/9_{1}$ I	0	95	5.2	8	2400	790	490	270
23	SCB $1/9_{2}$ I	0	61	5.2	8	3500	1700	230	490
24	SCB $1/9_{3}$ I	0	85	4.9	6.5	3500	1300	790	120
25	SCB $1/9_{4}$ I	0	70+ cm	5	6	<24000	5400	1100	1400
26	SCB $1/9_{5}$ I	0	58	4.2	4.5	9200	3500	460	170
27	SCB $1/9_{6}$ I	0	55	4.3	5	9200	5400	790	170
28	SCB $1/9_{7}$ I	0	58	4	5.5	<24000	2400	330	170
29	SCB $1/9_{8}$ I	6	60	5.1	5.5	5400	330	50	80
30	SCB $1/9_{12}$ I	6	65	4.2	4.5	790	50	20	20
31	SCB $1/9_{9}$ I	8	38	4	5 (2.5)	330	50	20	50
32	SCB $1/9_{10}$ I	0	28	2.8	5 (4.0)	5400	200	20	60
33	SCB $1/9_{11}$ I	6.8	110 cm	3.6	4.3	790	130	80	50
34	SCB $1/9_{1}$ II	8	80 cm	4.5	5	130	20	20	20
35	SCB $1/9_{2}$ II*	--	--	4	--	80	20	>20	>20

*Engine trouble

Table 2 (continued)

NO.	SAMPLE SITE	SALIN.	TURB.	WT	AT	LT	BGB	EC	EMB
36	SCB $1/9_3$ II*	--	--	4.2	--	330	230	>20	50
37	SCB $1/9_4$ II*	--	--	5.2	--	3500	490	50	40

*Engine trouble

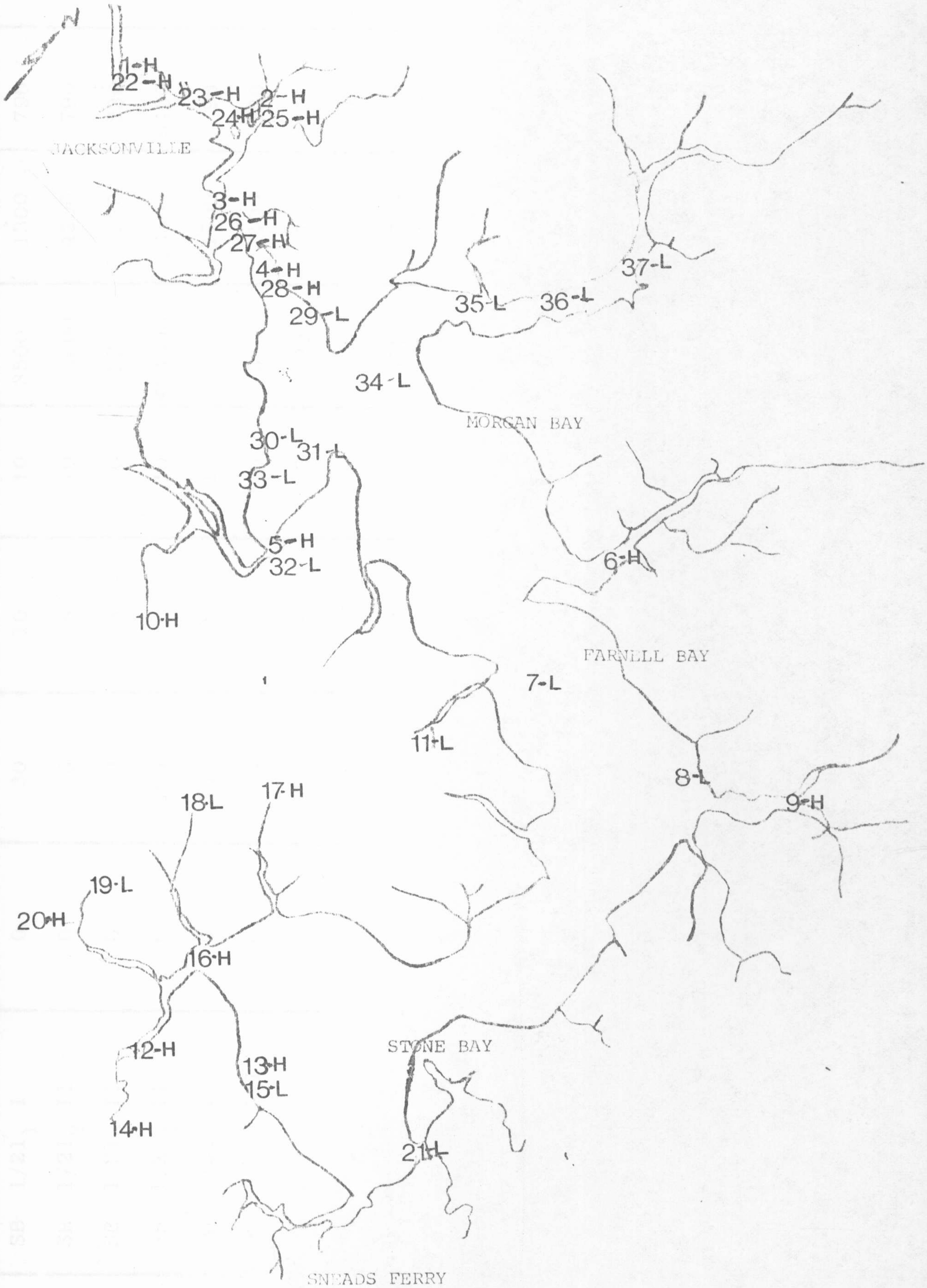


FIGURE 2. SAMPLING STATIONS – NEW RIVER ESTUARY
JANUARY 21, 1981 – FEBRUARY 28, 1981

NO.	SAMPLE SITE	SALIN.	TURB.	WT	AT	LT	BGB	EC	EMB
1	SB $1/21_1$ I	0	30	10	10	3500	1300	790	1300
2	SB $1/21_2$ II	0	5	8	10	16000	4200	790	450
3	SB $1/21_3$ II	0	30	8	10	230	230	230	230
4	SB $1/21_4$ II	0	165	9	10	<24000	16000	5400	1400
5	SB $1/21_1$ II	0	155	8	10	350	1700	93	120
6	SB $1/21_1$ III	0	55	10	10	3500	1100	120	61
7	SB $1/21_1$ V	2	50	9	9	2200	790	790	790
8	SB $1/21_2$ V	1	65	8	9	1100	460	45	110
9	SB $1/21_3$ V	9	30	9	9	3500	790	130	220
10	SB $1/21_4$ V	0	65	9	9	130	130	45	20
11	SB $1/21_5$ V	0	45	9	9	230	230	130	45
12	SB $1/21_6$ V	0	55	7	12	3500	1700	700	1400
13	SCB $2/4_1$ II	0	85	4	-1	<16000	<16000	<16000	<16000
14	SCB $2/4_2$ II	11	45	7	-2	<16000	<16000	3500	810
15	SCB $2/4_3$ II	0	20	4.5	-2	<16000	<16000	720	810
16	SCB $2/4_4$ II	0	10	5	0	<16000	720	150	190
17	SCB $2/4_5$ II	4	50	6.5	0	<16000	<16000	810	810
18	SCB $2/4_6$ II	0	22	5	1	<16000	<16000	720	810
19	SCB $2/4_7$ II	2	46	6.5	2	<16000	<16000	640	<16000

NO.	SAMPLE SITE	SALIN.	TURB.	WT	AT	LT	BGB	EC	EMB
20	SCB 2/4_8 II	0	39	5	2	<16000	16000	450	16000
21	SCB 2/4_9 II	4	50	6	1	<16000	<16000	720	810
22	SCB 2/4_1 III	0	88	4	-1.5	<16000	<16000	320	<16000
23	SCB 2/4_1 IV	0	92	1.5	-2	810	810	210	320
24	SCB 2/4_2 IV	0	79	3	-2	<16000	810	260	320
25	SCB 2/4_3 IV	0	48	3	-2	<16000	810	910	320
26	SCB 2/4_4 IV	0	30	2	-1.5	<16000	16000	320	320
27	SCB 2/28_1 I	2	40	11	19	790	330	130	330
28	SCB 2/28_1 II	0	30	11	15	230	230	78	230
29	SCB 2/28_2 II	5	45	13.5	19	1300	490	78	220
30	SCB 2/28_3 II	0	20	11	18	270	170	20	110
31	SCB 2/28_4 II	12	30	12	19	130	45	20	45
32	SCB 2/28_5 II	12	30	11	18	68	45	45	45
33	SCB 2/28_1 III	18	15	--	15	0	0	0	0
34	SCB 2/28_{1A} III	25	10	--	15	20	20	20	20
35	SCB 2/28_2 III	15	22	13	15	0	0	0	0
36	SCB 2/28_3 III	15	30	11	16	78	45	20	20
37	SCB 2/28_4 III	14	20	12	17	0	0	0	0

NO.	SAMPLE SITE	SALIN.	TURB.	WT	AT	LT	BGB	EC	EMB

Table 3 (continued)

NO.	SAMPLE SITE	SALIN.	TURB.	WT	AT	LT	BGB	EC	EMB
38	SCB $2/28_5$ III	15	15	13	18	20	0	0	0
39	SCB $2/28_6$ III	17	25	13	18	0	0	0	0
40	SCB $2/28_1$ IV	0	35	9	11	20	20	20	20
41	SCB $2/28_2$ IV	0	60	8	11	110	20	20	20
42	SCB $2/28_3$ IV	1	35	8.5	11	460	460	330	330
43	SCB $2/28_4$ IV	0	30	9	23	45	0	0	0
44	SCB $2/28_5$ IV	0	55	11	20	230	0	0	0
45	SCB $2/28_1$ V	18	15	--	15	0	0	0	0
46	SCB $2/28_7$ IV	--	--	--	15	2400	130	45	78
47	SCB $2/28_8$ IV	14	20	14	17	20	18	0	18
48	SCB $2/28_9$ IV	12	15	14	16	140	45	45	20
49	SCB $2/28_{10}$ IV	6	45	16	14	280	130	45	130
50	SCB $2/28_2$ V	0	40	13	21	330	330	330	45

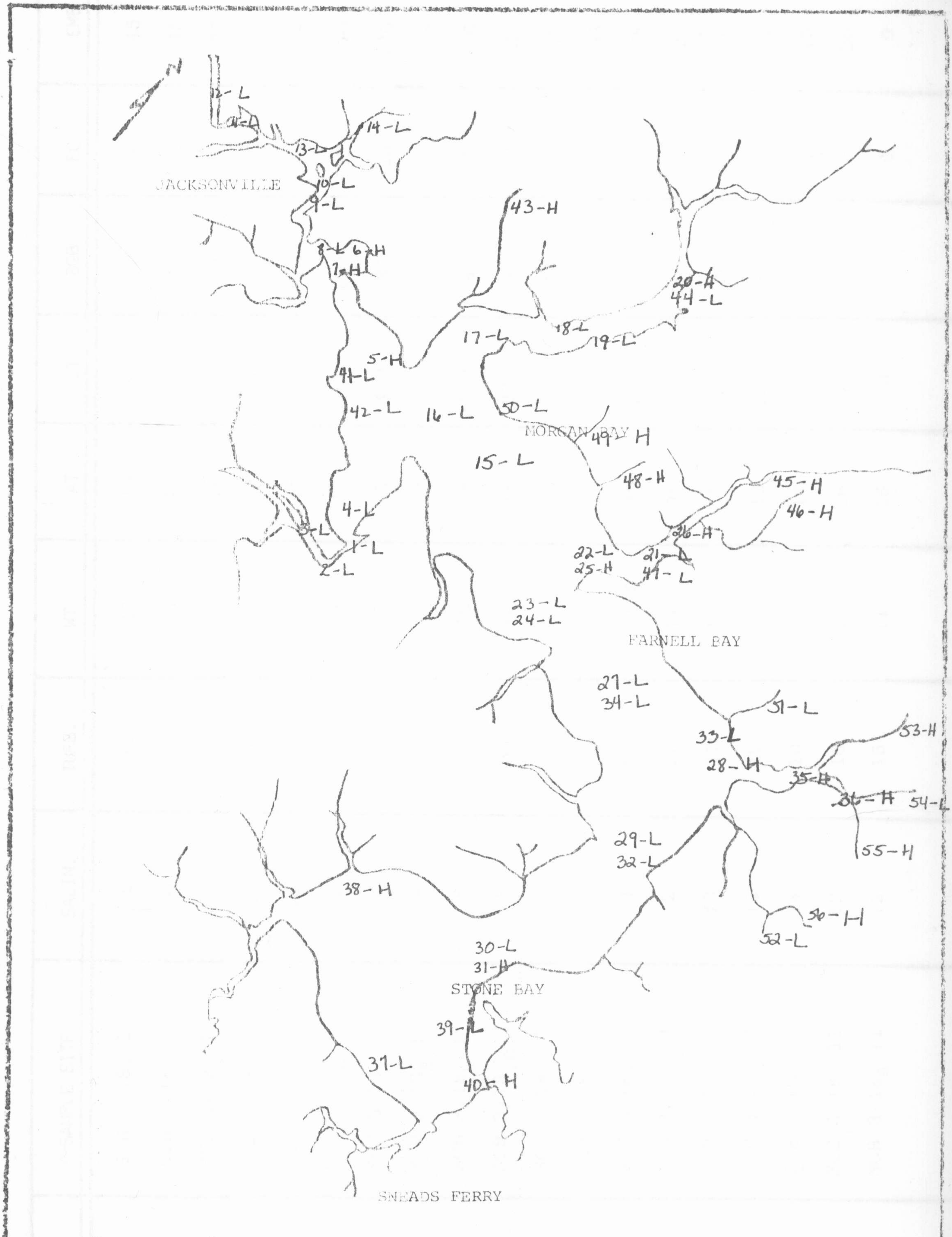


FIGURE 3. SAMPLING STATIONS - NEW RIVER ESTUARY
MARCH 18, 1981 - APRIL 15, 1981

FIGURE 3. SAMPLING STATION [illegible] NEW [illegible]
MARCH 16, 1981 - APRIL 16, 1981

Table 4. Summary of data from March 18, 1981 to April 15, 1981
New River Estuary

NO.	SAMPLE SITE	SALIN.	TURB.	WT	AT	LT	BGB	EC	EMB
1	SCB $3/18_{1}$ I	10	15	11	13	460	45	0	45
2	SCB $3/18_{2}$ I	6	15	17	12	130	45	0	45
3	SCB $3/18_{3}$ I	4	16	11.5	16	270	61	0	20
4	SCB $3/18_{4}$ I	15	19	10.5	16	20	20	0	0
5	SCB $3/18_{5}$ I	15	21	11	17	110	110	110	68
6	SCB $3/18_{6}$ I	9	35	11	17	1100	1100	140	170
7	SCB $3/18_{7}$ I	8	33	11	17	490	230	45	130
8	SCB $3/18_{8}$ I	8	30	12	17	490	170	45	68
9	SCB $3/18_{9}$ I	8	25	12	18	1700	45	40	0
10	SCB $3/18_{10}$ I	6	35	12	18	220	45	20	20
11	SCB $3/18_{11}$ I	3	30	12	18	490	110	78	45
12	SCB $3/18_{12}$ I	1	30	13	19	320	110	45	68
13	SCB $3/18_{13}$ I	4	30	11.5	20	790	490	45	78
14	SCB $3/18_{14}$ I	2	38	11	20	1300	110	40	20
15	SCB $3/18_{1}$ II	13	17	11	13	20	20	20	0
16	SCB $3/18_{2}$ II	13	19	10.5	13	130	130	20	130
17	SCB $3/18_{3}$ II	14	10	11	17	170	68	68	40
18	SCB $3/18_{4}$ II	12	16	11	16	45	20	0	20
19	SCB $3/18_{5}$ II	12	15	11	16	0	0	0	0

Table 4 (continued)

NO.	SAMPLE SITE	SALIN.	TURB.	WT	AT	LT	BGB	EC	EMB
20	SCB 3/18$_6$ II	6	17	11.5	16	490	490	20	220
21	SCB 3/28$_1$ II	10	--	13	12	460	460	20	68
22	SCB 3/28$_2$ II	17	--	12	13	120	120	20	120
23	SCB 3/28$_3$ II	19	--	12	14	0	0	0	0
24	SCB 3/28$_4$ II	17	--	13	20	18	18	0	0
25	SCB 3/28$_5$ II	17.5	--	11	19	2200	2200	0	2200
26	SCB 3/28$_6$ II	15.5	--	16	22	490	220	20	220
27	SCB 3/28$_1$ III	21	--	12.5	13	78	78	0	78
28	SCB 3/28$_2$ III	18	--	12.2	13	230	130	45	130
29	SCB 3/28$_3$ III	19	--	12	17	18	18	0	0
30	SCB 3/28$_4$ III	21.5	--	12.5	18	0	0	0	0
31	SCB 3/28$_5$ III	24	--	12.5	18	310	310	0	170
32	SCB 3/28$_6$ III	23	--	11.8	19	78	78	20	78
33	SCB 3/28$_7$ III	22.5	--	15.5	20	45	45	18	45
34	SCB 3/28$_8$ III	19	--	11.5	18	0	0	0	0
35	SCB 3/28$_1$ IV	10 (ref.)	--	13.5	15	1800	1800	18	1800
36	SCB 3/28$_2$ IV	4 (ref.)	--	12.5	17	170	170	18	130
37	SCB 3/28$_1$ V	23.8	--	13.5	18	20	0	0	0
38	SCB 3/28$_2$ V	24.5 (23.5 ref.)	--	12	16	310	310	0	170

Table 4 (continued)

NO.	SAMPLE SITE	SALIN.	TURB.	WT	AT	LT	BGB	EC	EMB
39	SCB $3/28_1$ VII	23.5 (20 R)	--	12.5	18	0	0	0	0
40	SCB $3/28_2$ VII	24	--	13	19	490	490	0	130
41	SCB $4/15_1$ I	10	10	22	19	490	140	0	40
41	SCB $4/15_2$ I	12	10	20	19	330	330	0	40
43	SCB $4/15_1$ II	4	12	18	19	2200	950	0	640
44	SCB $4/15_2$ II	9	5	23	19	5400	3500	0	74
45	SCB $4/15_3$ II	4	17	20	22	9200	9200	0	5400
46	SCB $4/15_4$ II	0	15	17	22.5	5400	3500	0	3500
47	SCB $4/15_5$ II	15	15	22	20	230	130	0	45
48	SCB $4/15_6$ II	0	17	21	23	2200	2200	0	1100
49	SCB $4/15_7$ II	0	10	20	23	2400	1300	0	170
50	SCB $4/15_8$ II	15	0	23	21	230	20	0	20
51	SCB $4/15_1$ III	0	5	21	23	<16000	720	0	60
52	SCB $4/15_2$ III	0	5	16	20	1100	1100	0	68
53	SCB $4/15_1$ IV	0	5	18	21	400	330	0	330
54	SCB $4/15_2$ IV	0	5	18	25	1100	1100	0	45
55	SCB $4/15_3$ IV	0	2	19	23	9200	2800	0	110
56	SCB $4/15_4$ IV	0	10	14	22	9200	5400	0	280

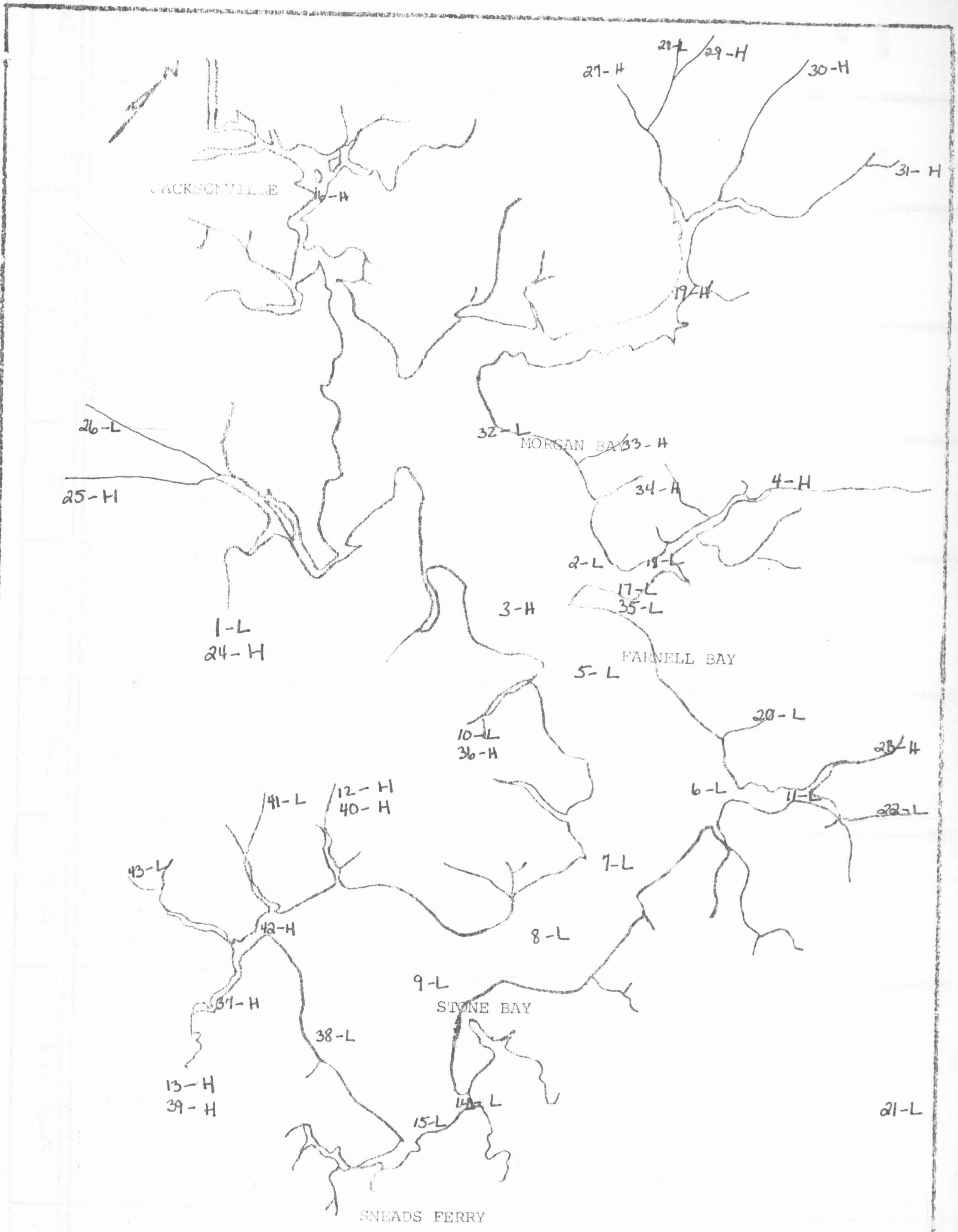


FIGURE 4. SAMPLING STATIONS - NEW RIVER ESTUARY
APRIL 29, 1981 - MAY 27, 1981

Table 5. Summary of data from April 29, 1981 to May 27, 1981
New River Estuary

NO.	SAMPLE SITE	SALIN.	TURB.	WT	AT	LT	BGB	EC	EMB
1	SCB $4/29_1$ I	0	5	20	--	490	170	20	68
2	SCB $4/29_1$ II	17	3	21.5	25	130	0	0	0
3	SCB $4/29_2$ II	19	8	21	25	1700	1700	1700	0
4	SCB $4/29_3$ II	4	8	23.5	25	330	330	130	130
5	SCB $4/29_1$ III	20	0	22	25	78	0	0	0
6	SCB $4/29_2$ III	21	1	22	26	230	0	0	0
7	SCB $4/29_3$ III	21	10	22	26	170	18	18	0
8	SCB $4/29_4$ III	25	5	22	26	170	18	18	0
9	SCB $4/29_5$ III	28	5	22	27	130	0	0	0
10	SCB $4/29_6$ III	0	10	20	25	790	330	0	20
11	SCB $4/29_1$ IV	20	5	22	26	230	0	0	0
12	SCB $4/29_1$ V	14	5	25	27	790	330	330	170
13	SCB $4/29_2$ V	2	1	20.5	27	1300	1300	45	45
14	SCB $4/29_1$ VI	29	1	22	27	230	0	0	0
15	SCB $4/29_2$ VI	30	1	22.5	27.5	230	20	20	20
16	SCB $5/13_1$ I	0	--	23	24	<16000	<16000	<16000	320
17	SCB $5/13_1$ II	9	--	27	26	490	330	0	45
18	SCB $5/13_2$ II	4	--	24	24	210	210	20	40
19	SCB $5/13_3$ II	4	--	26	27	9200	9200	330	200

Table 5 (continued)

NO.	SAMPLE SITE	SALIN.	TURB.	WT	AT	LT	BGB	EC	EMB
20	SCB $5/13_1$ III	0	--	25	26	460	68	0	20
21	SCB $5/13_1$ IV	--	--	19	24.5	16000	5400	78	37
22	SCB $5/13_2$ IV	0	--	19	24	840	840	45	78
23	SCB $5/13_3$ IV	0	--	19	26	2200	2200	110	110
24	SCB $5/27_1$ I	1	120	19	24	2400	2400	790	1300
25	SCB $5/27_2$ I	1	60	20	22	2400	1300	230	490
26	SCB $5/27_3$ I	1	60	20	22	790	490	40	68
27	SCB $5/27_1$ II	1	70	21	24	1600	540	220	260
28	SCB $5/27_2$ II	2	85	20	23	2200	640	0	0
29	SCB $5/27_3$ II	1	120	20	23	5400	3500	1300	790
30	SCB $5/27_4$ II	1	50	20	24	2400	790	78	170
31	SCB $5/27_5$ II	1	60	20	24	1700	1300	230	330
32	SCB $5/27_6$ II	20	40	24	22	130	78	0	20
33	SCB $5/27_7$ II	1	50	21	23	5400	5400	330	220
34	SCB $5/27_8$ II	1	35	23	23	1100	790	490	490
35	SCB $5/27_9$ II	20	20	25	24	20	20	0	20
36	SCB $5/27_1$ III	1	70	20	23	1700	490	110	140
37	SCB $5/27_1$ V	8	80	25	24	3500	1700	330	130
38	SCB $5/27_2$ V	28	90	24	24	45	20	0	20

Table 5 (continued)

NO.	SAMPLE SITE	SALIN.	TURB.	WT	AT	LT	BGB	EC	EMB
39	SCB $5/27_3$ V	1	70	20	24.5	700	330	110	170
40	SCB $5/27_4$ V	2	90	23	23	790	790	330	220
41	SCB $5/27_5$ V	1	80	19	23	330	330	20	20
42	SCB $5/27_6$ V	21	40	23	24	490	490	40	330
43	SCB $5/27_7$ V	1	70	20	23	330	330	45	78

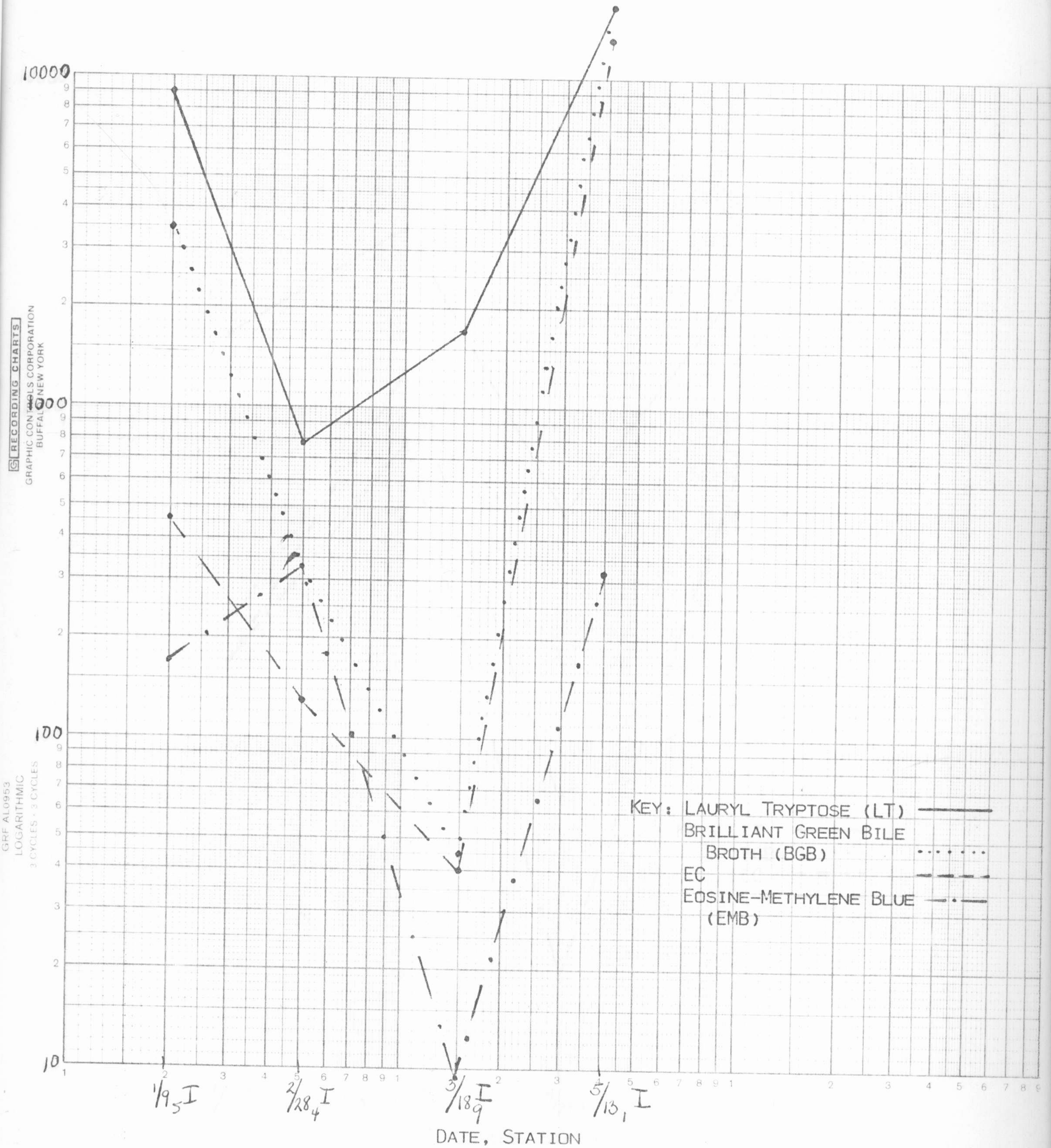


FIGURE 5. BACTERIOLOGICAL ANALYSES, JANUARY 1981 - MAY 1981
JACKSONVILLE

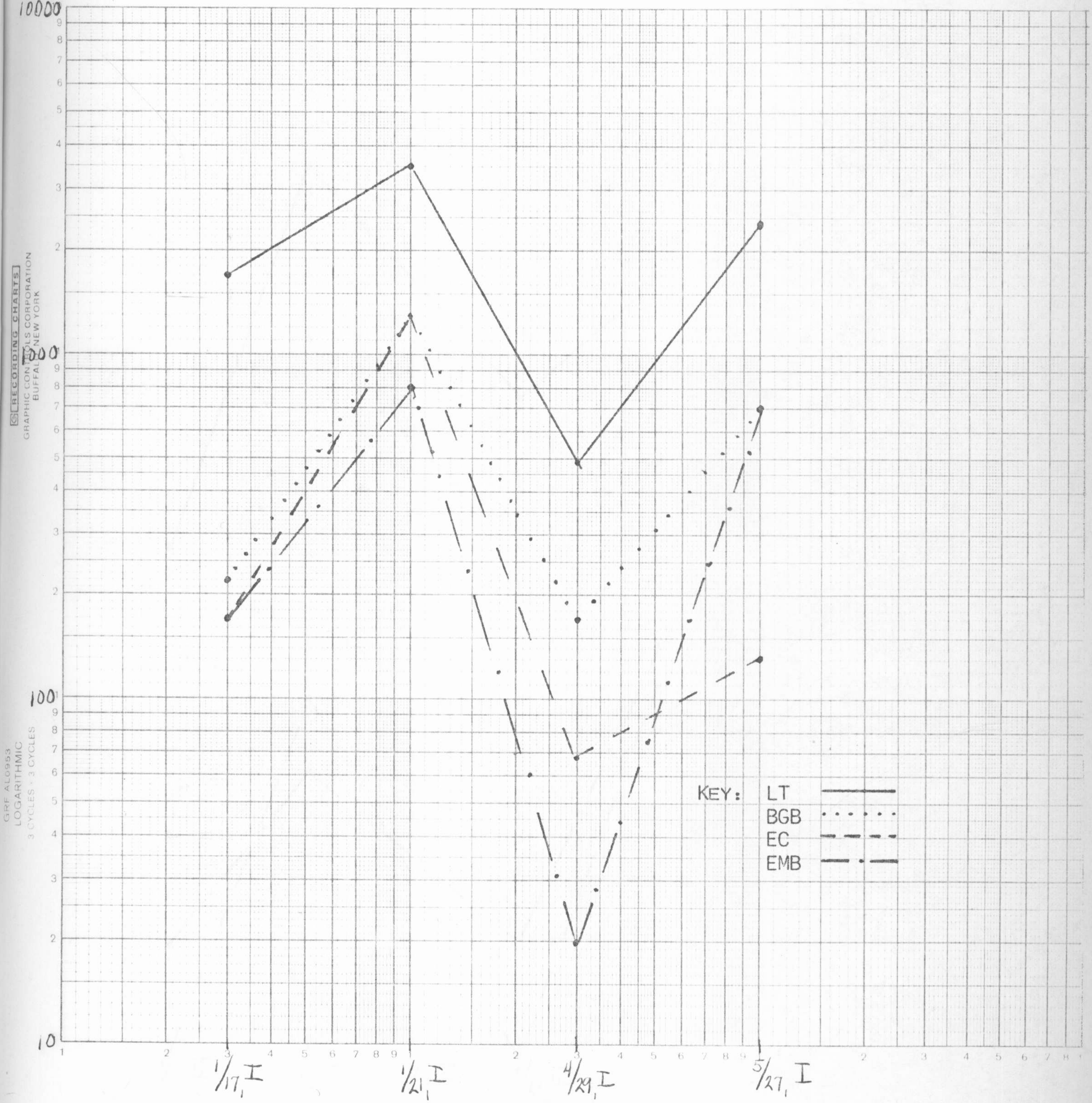


FIGURE 6. BACTERIOLOGICAL ANALYSES, JANUARY - MAY 1981
SOUTHWEST CREEK

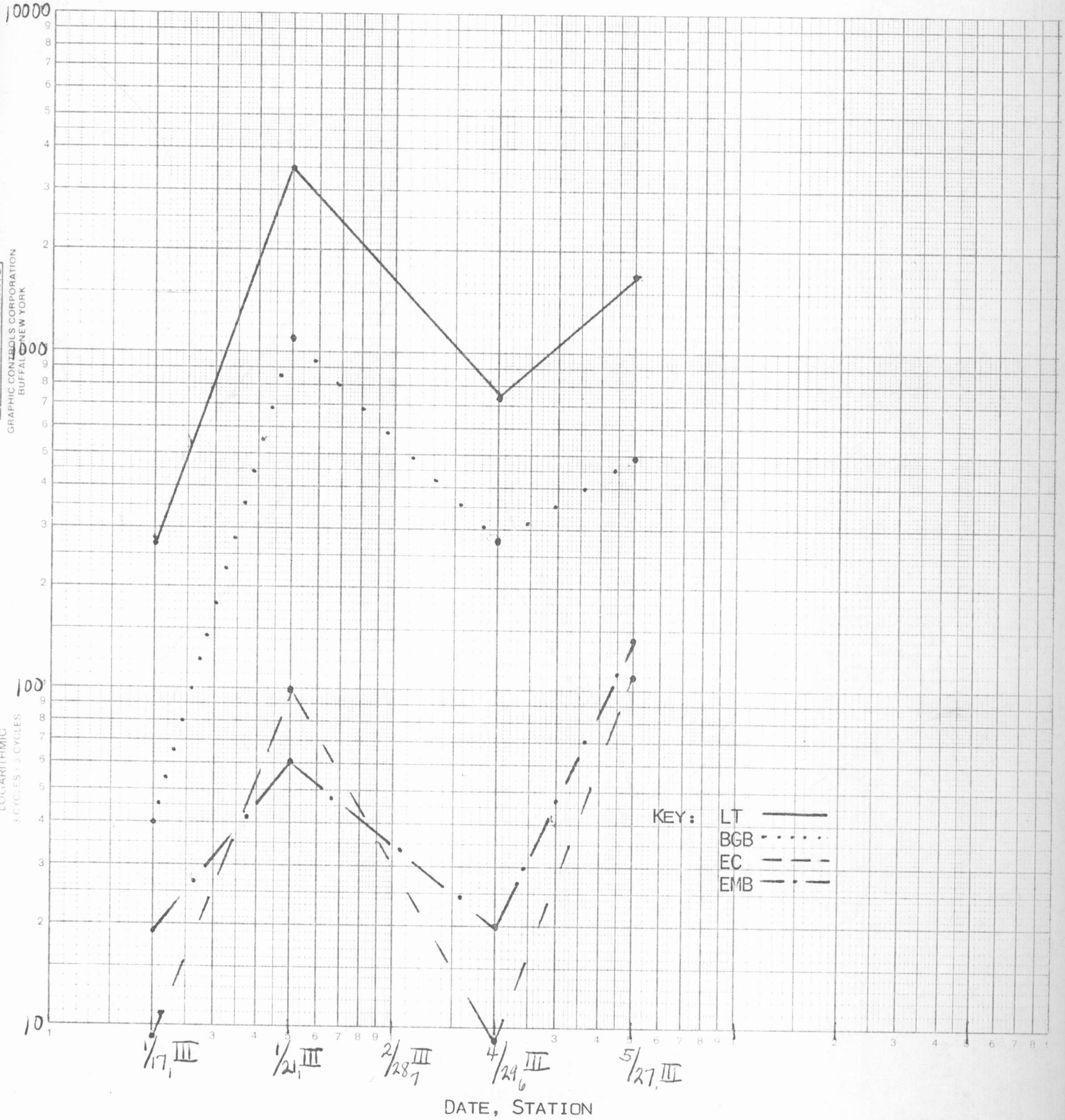


FIGURE 7. BACTERIOLOGICAL ANALYSES, JANUARY 1981 - MAY 1981
TOWN CREEK

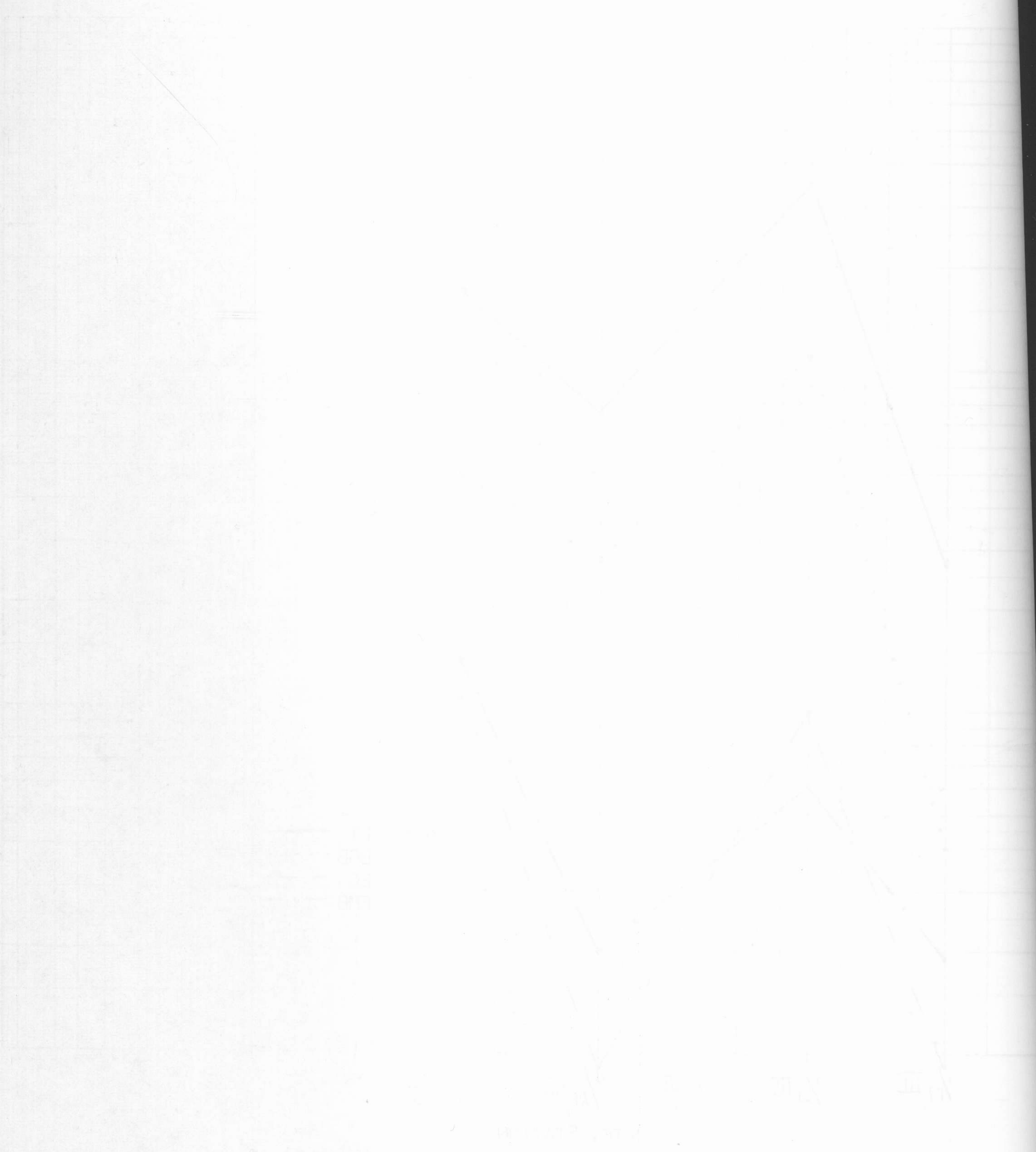


FIGURE [illegible] BACTERI[illegible]
TOWN CREEK

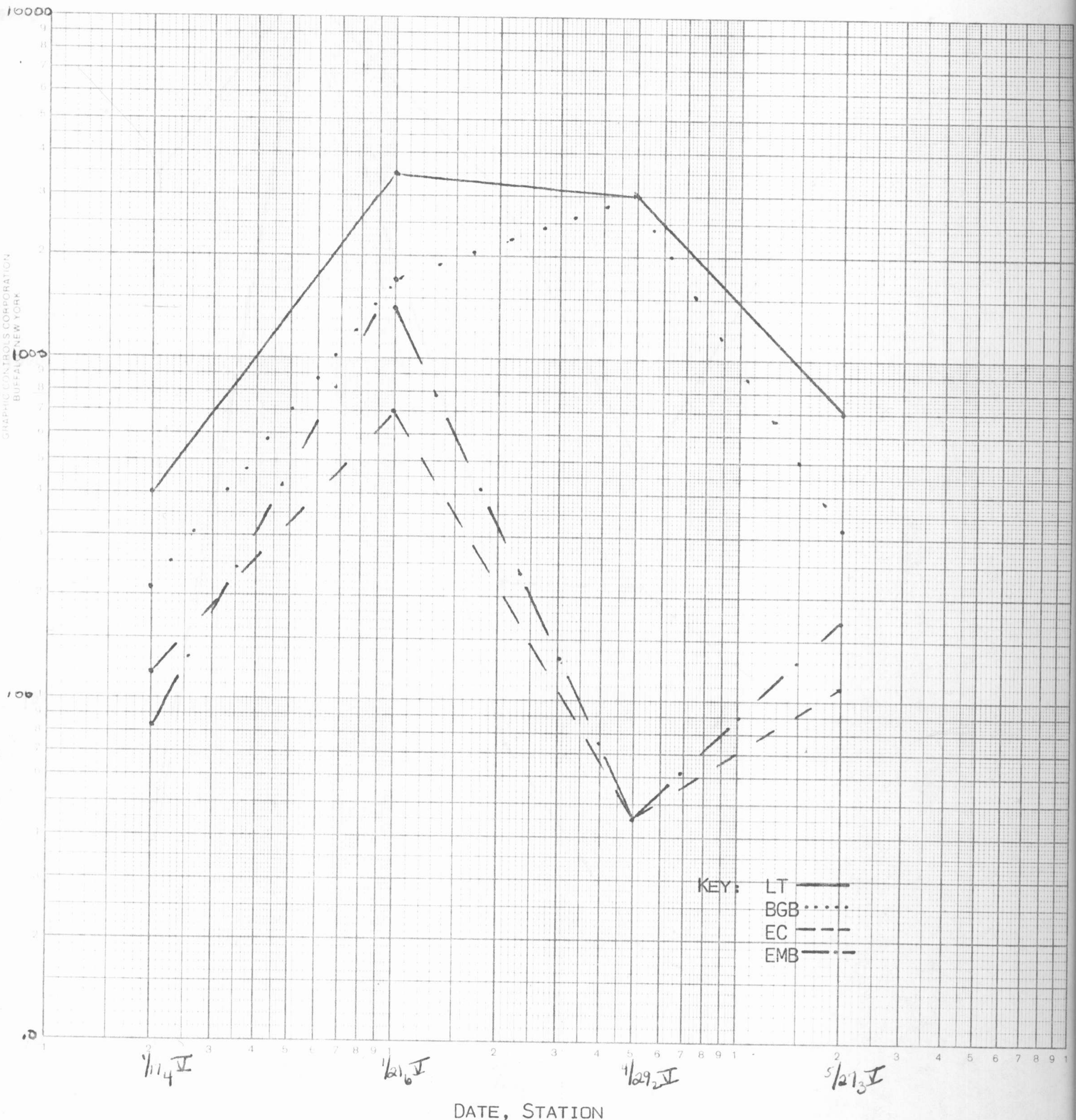


FIGURE 8. BACTERIOLOGICAL ANALYSES, JANUARY 1981 – MAY 1981
STONES CREEK

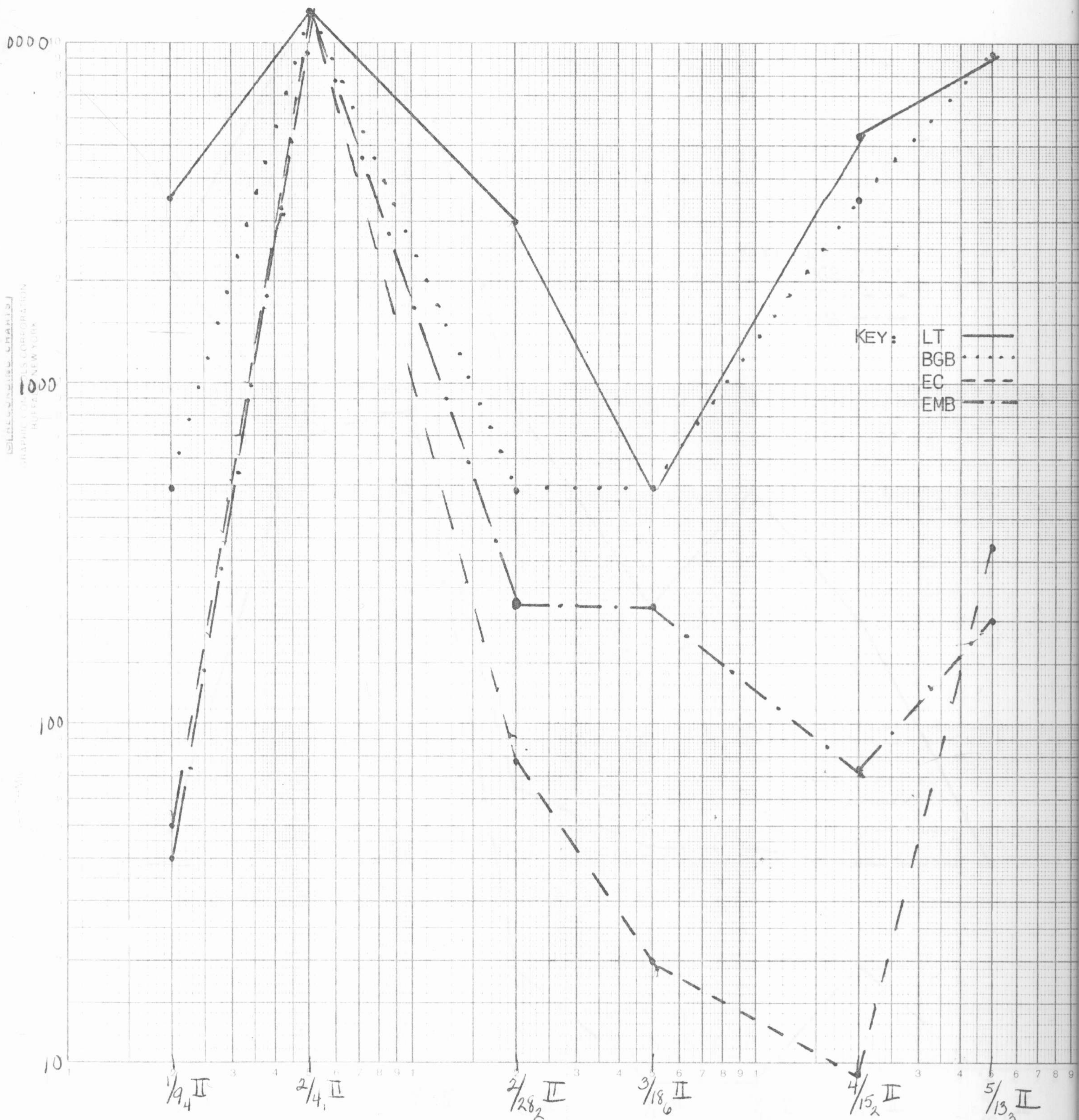


FIGURE 9. BACTERIOLOGICAL ANALYSES, JANUARY 1981 - MAY 1981
NORTHEAST CREEK

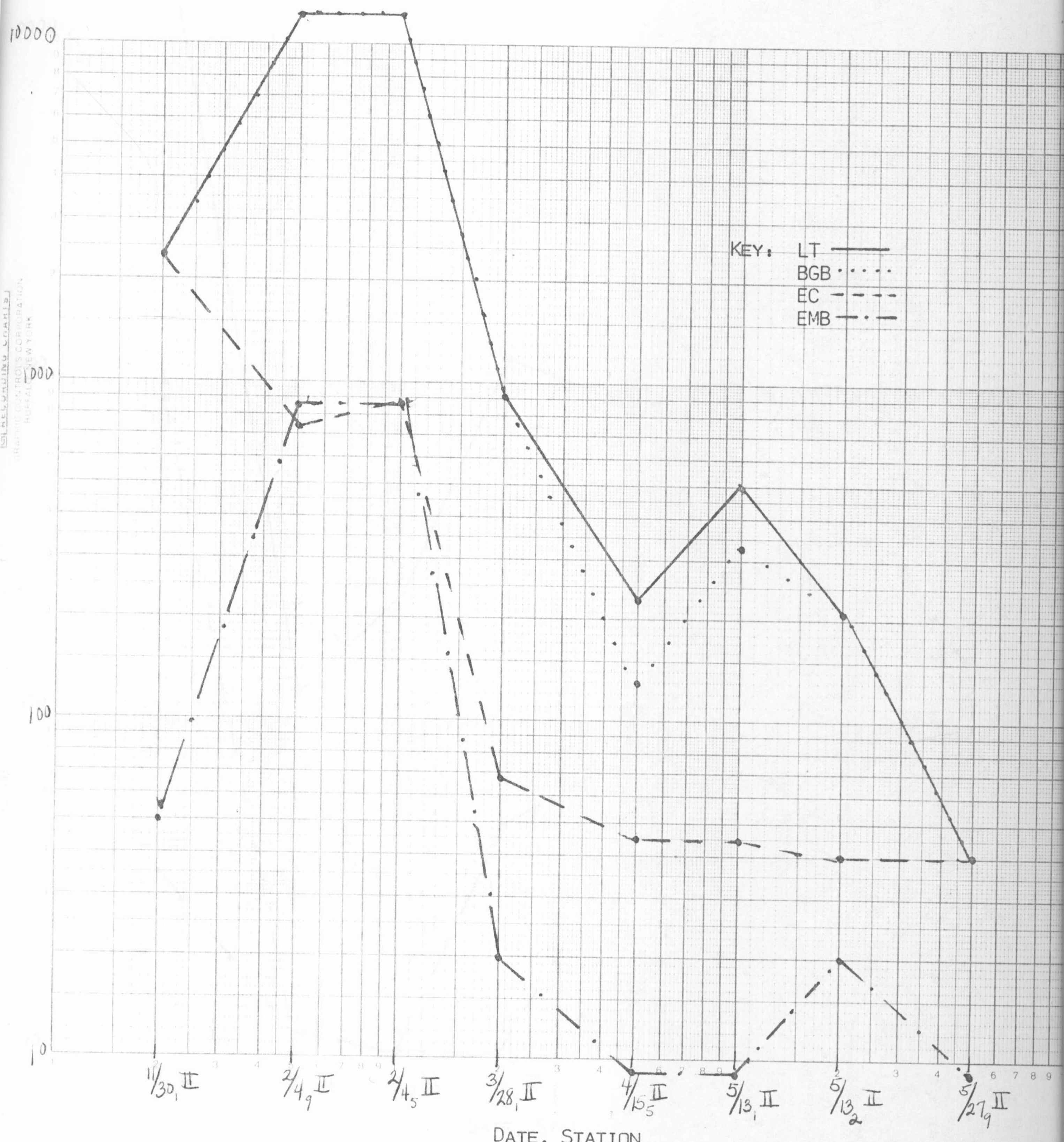


FIGURE 10. BACTERIOLOGICAL ANALYSES, NOVEMBER 1980 - MAY 1981
WALLACE CREEK

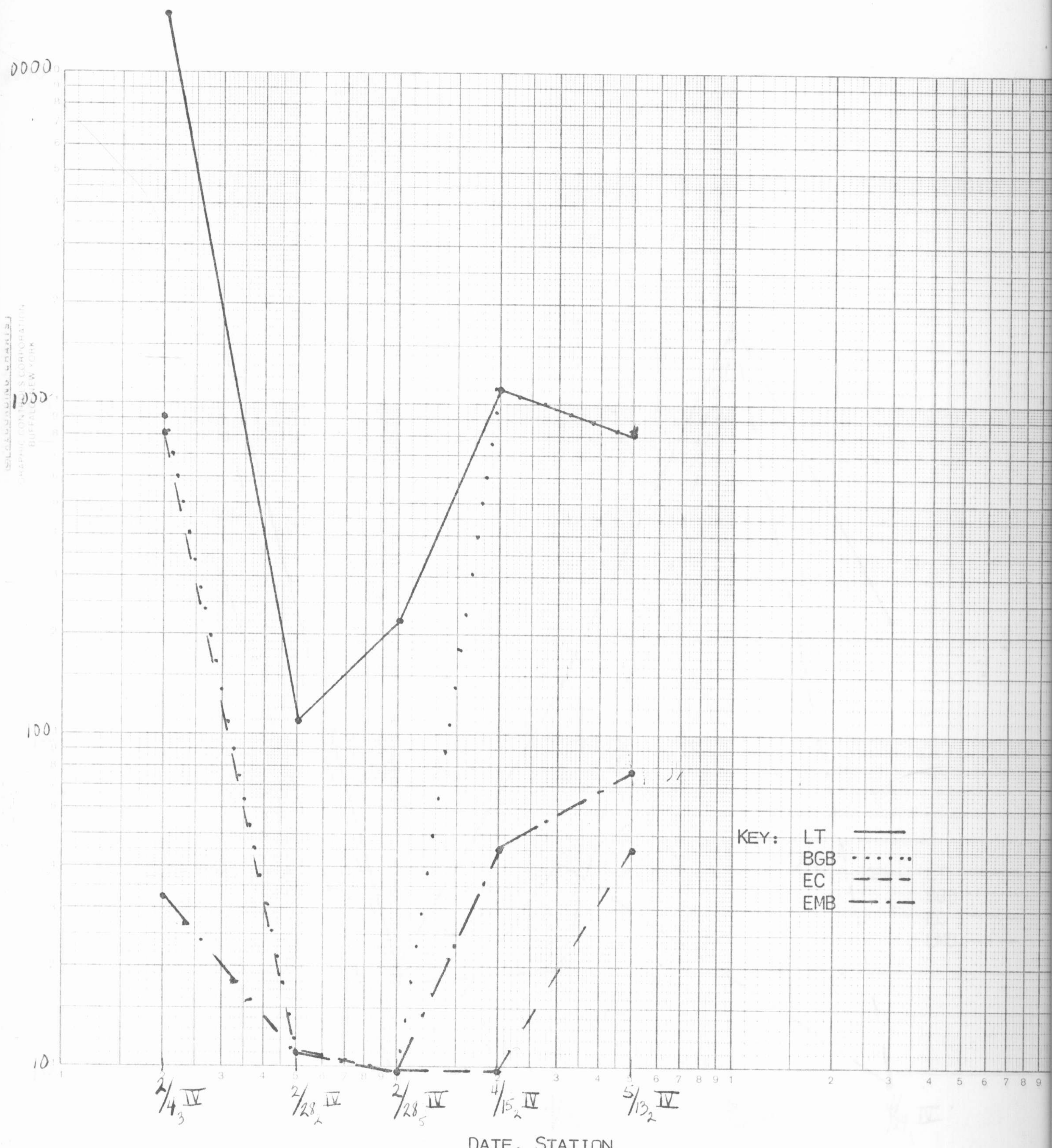


FIGURE 11. BACTERIOLOGICAL ANALYSES, FEBRUARY 1981 - MAY 1981
FRENCHS CREEK (HEAD)

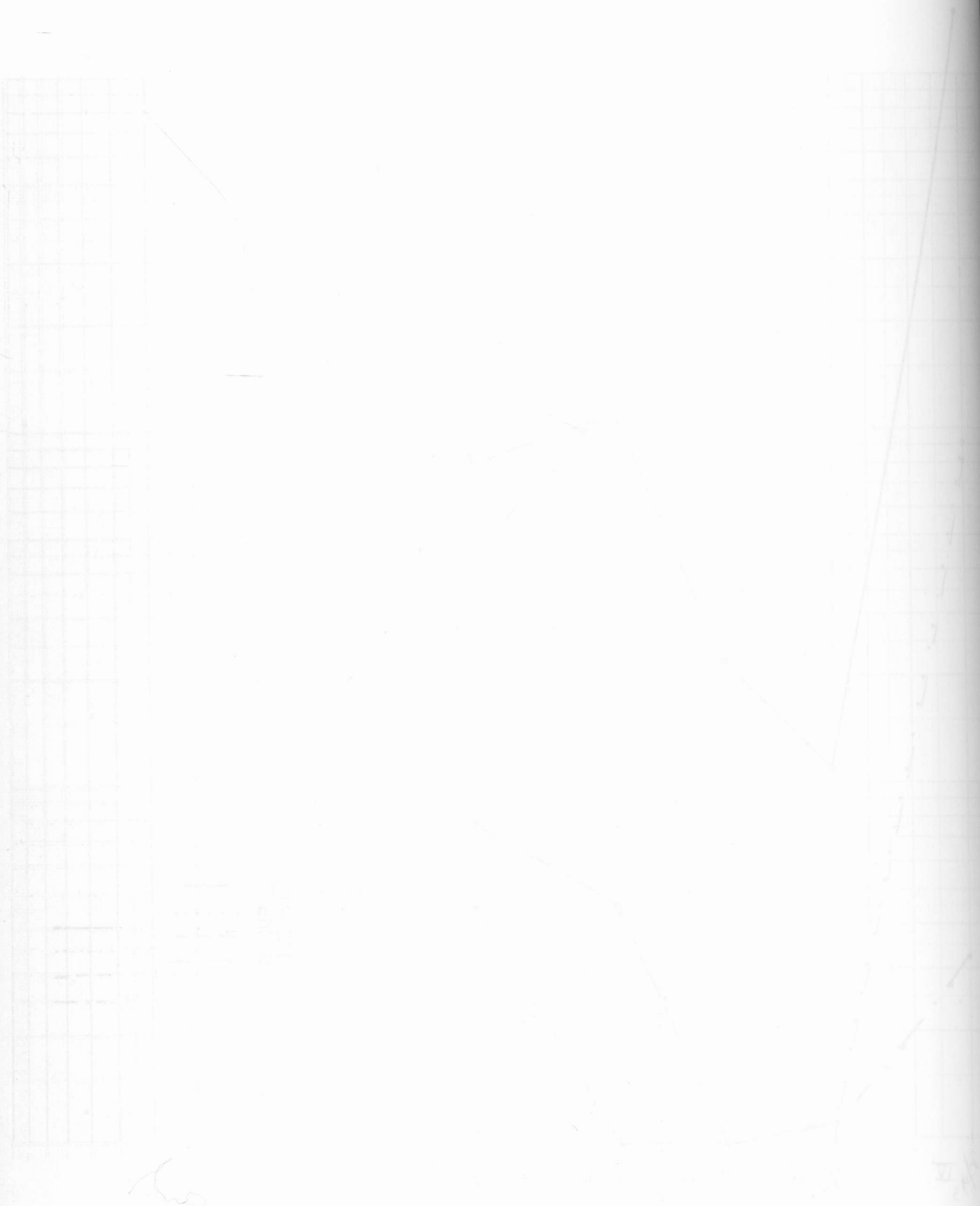


FIGURE 11. [illegible]

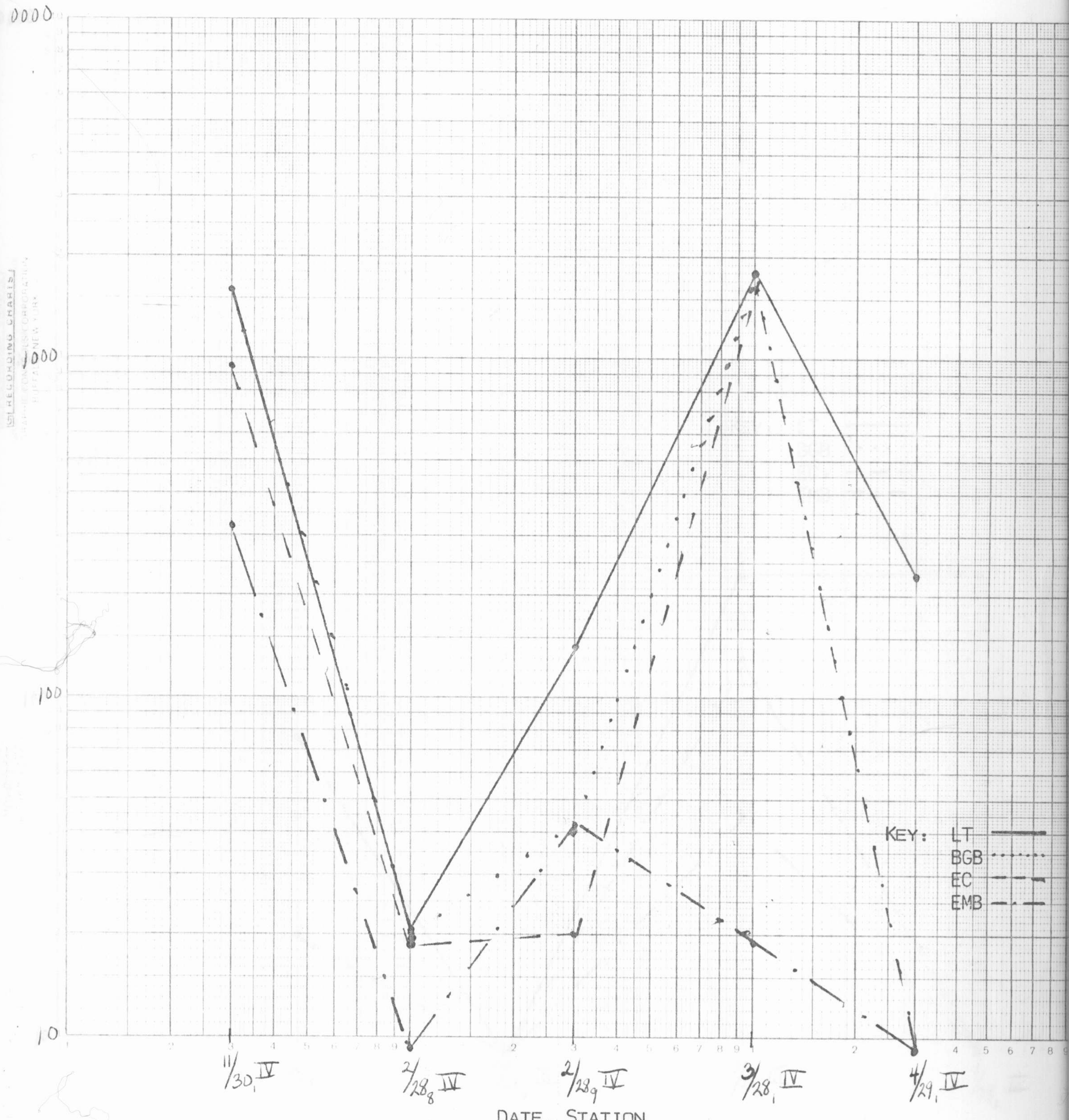


FIGURE 12. BACTERIOLOGICAL ANALYSES, NOVEMBER 1980 - APRIL 1981
FRENCHS CREEK (MIDDLE)

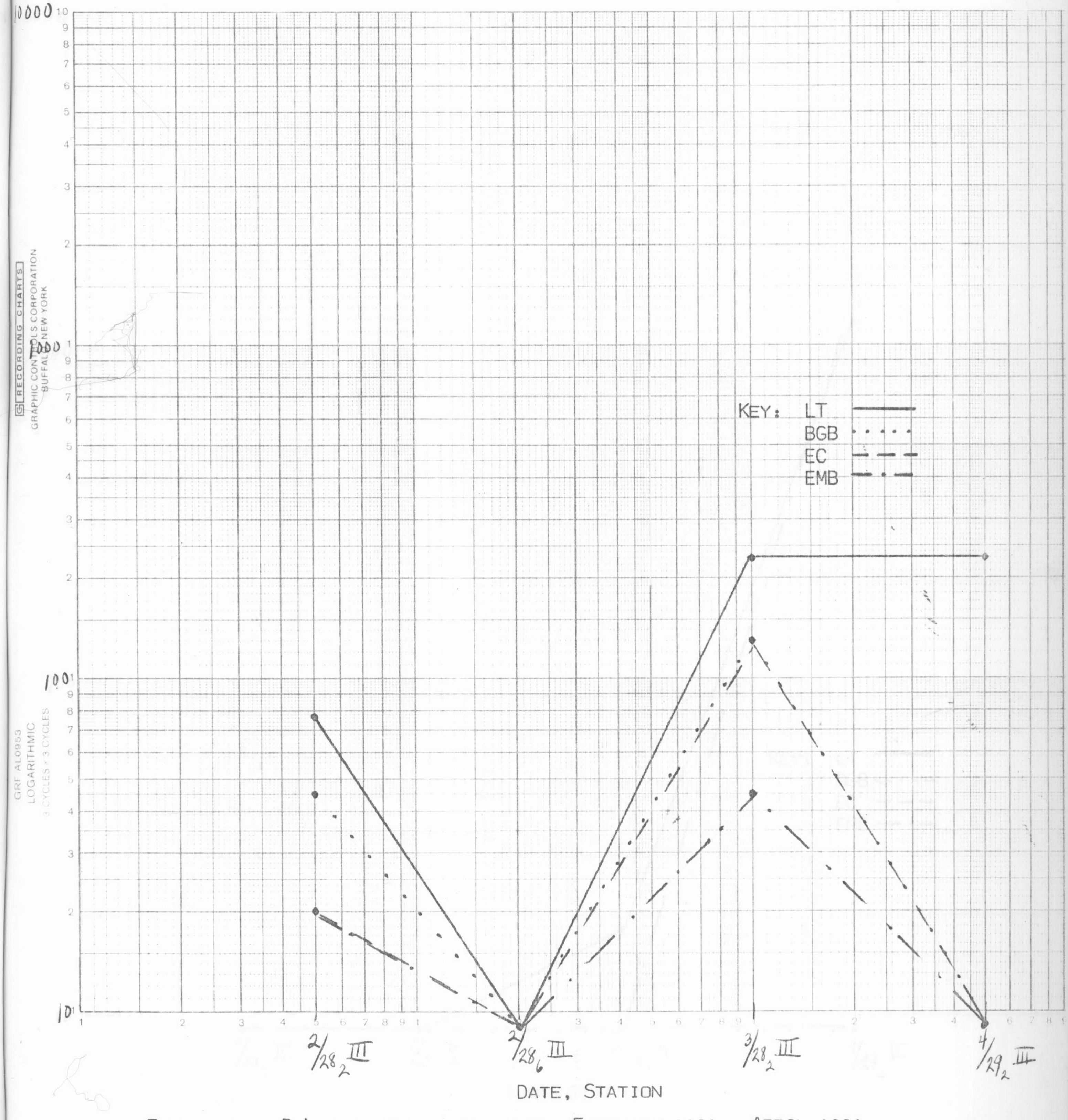


FIGURE 13. BACTERIOLOGICAL ANALYSES, FEBRUARY 1981 - APRIL 1981
FRENCHS CREEK (MOUTH)

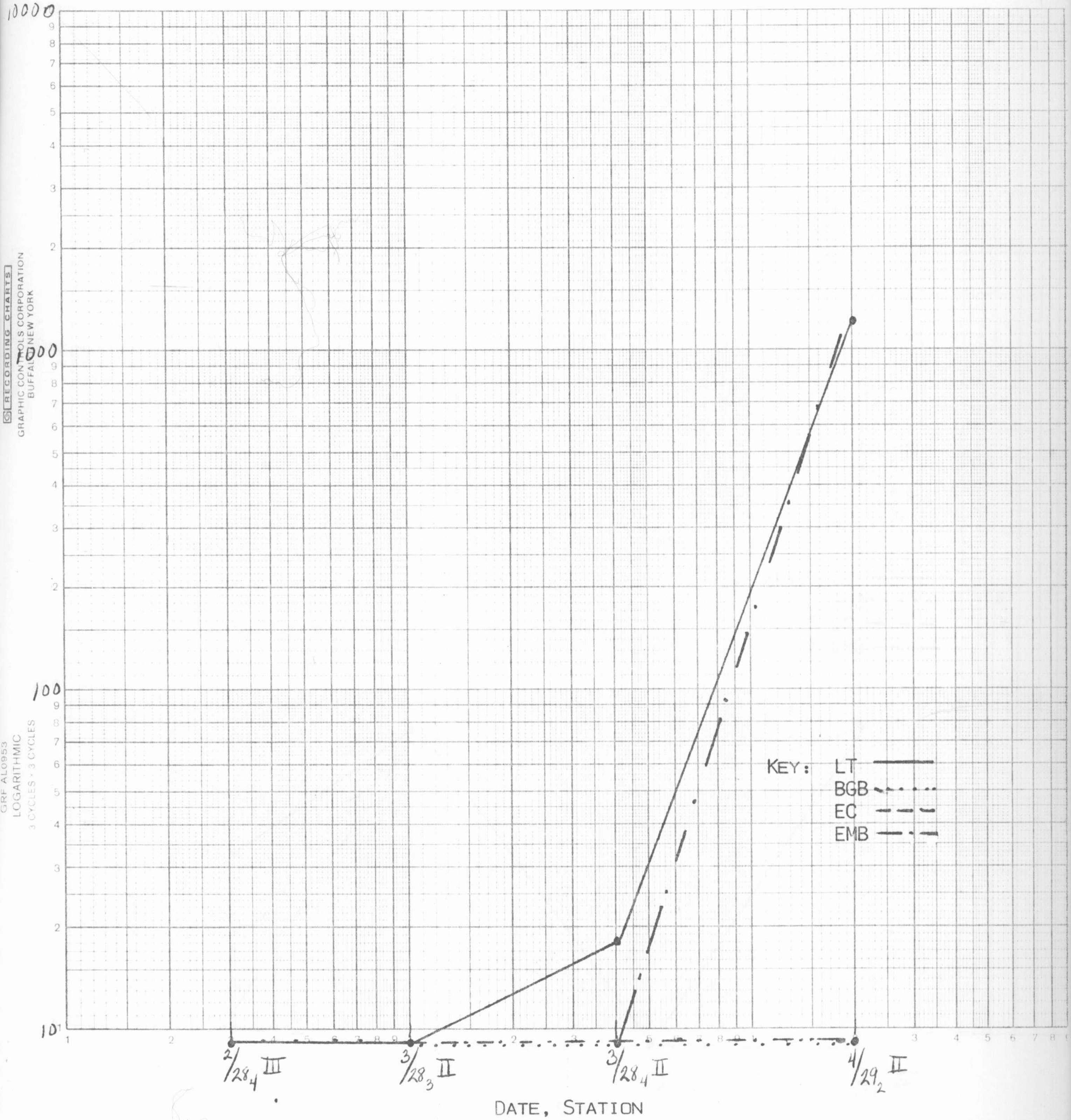


FIGURE 14. BACTERIOLOGICAL ANALYSES, FEBRUARY 1981 - APRIL 1981
MORGAN BAY

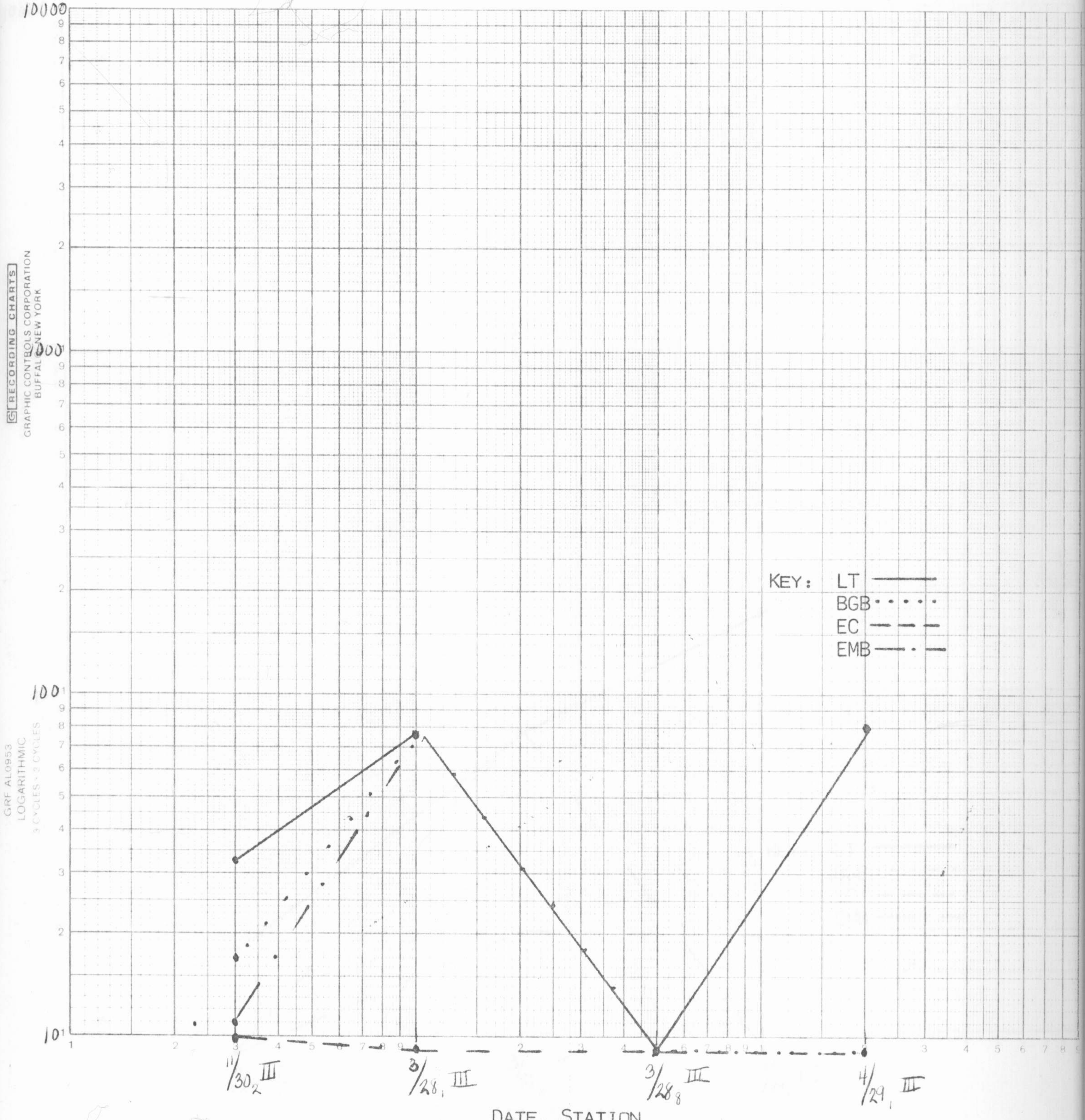


FIGURE 15. BACTERIOLOGICAL ANALYSES, NOVEMBER 1980 - APRIL 1981
FARNELL BAY

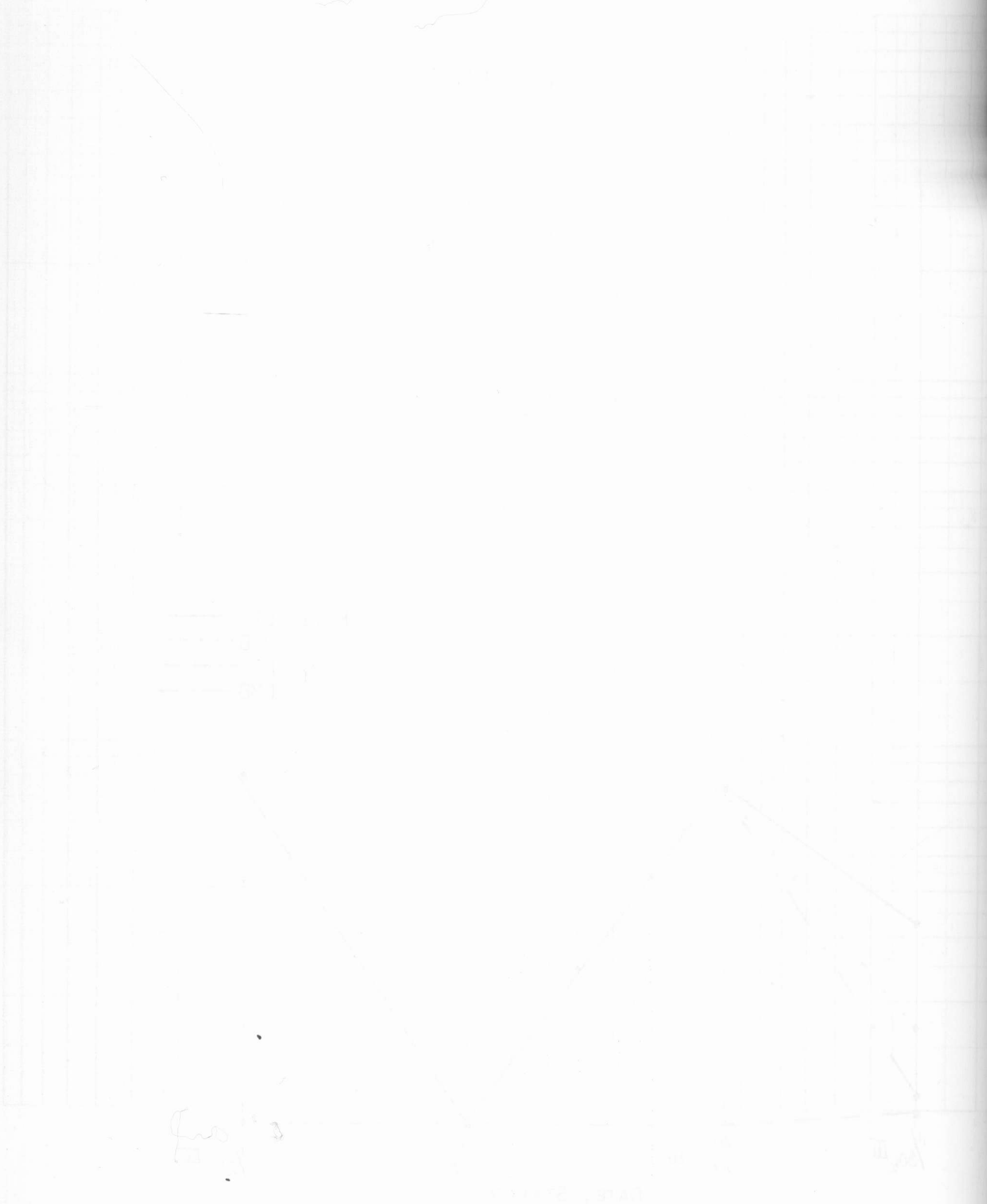


FIGURE 16. BACTERIOLOGICAL ANALYSES, [illegible] APRIL 1981
GARNELL BAY

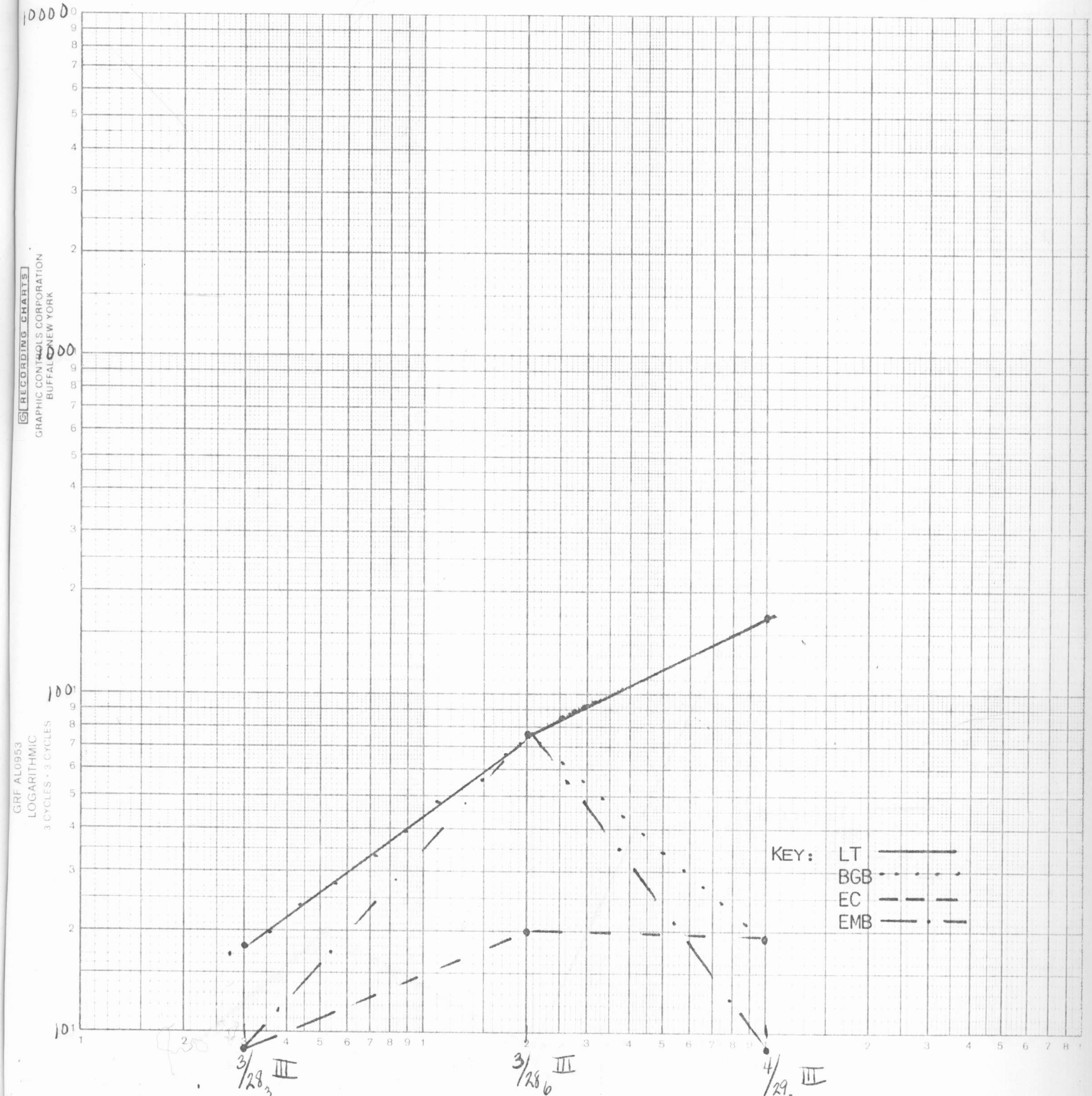


FIGURE 16. BACTERIOLOGICAL ANALYSES, MARCH 1981 - APRIL 1981
GREY POINT

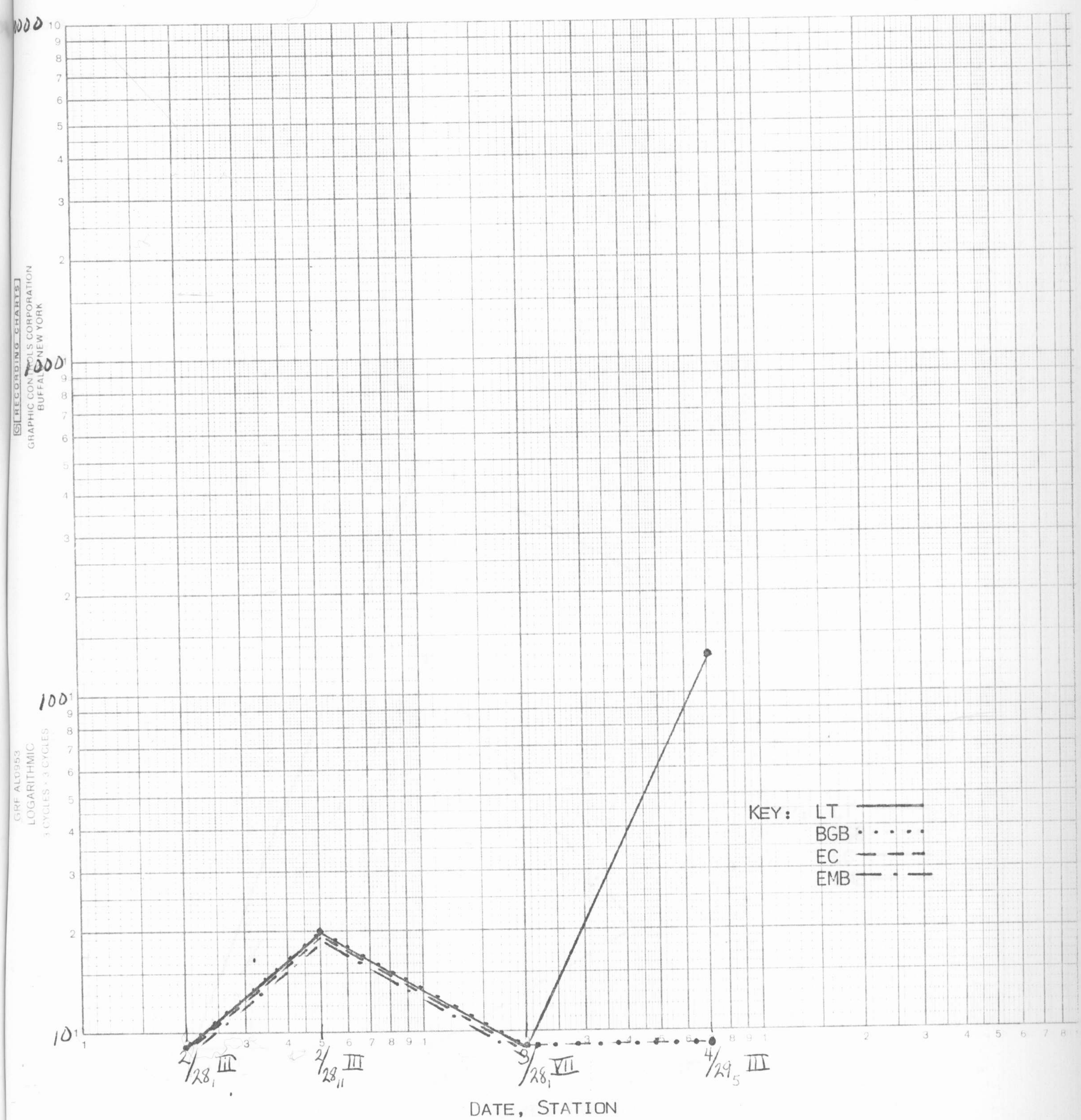


FIGURE 17. BACTERIOLOGICAL ANALYSES, FEBRUARY 1981 - APRIL 1981
STONES BAY

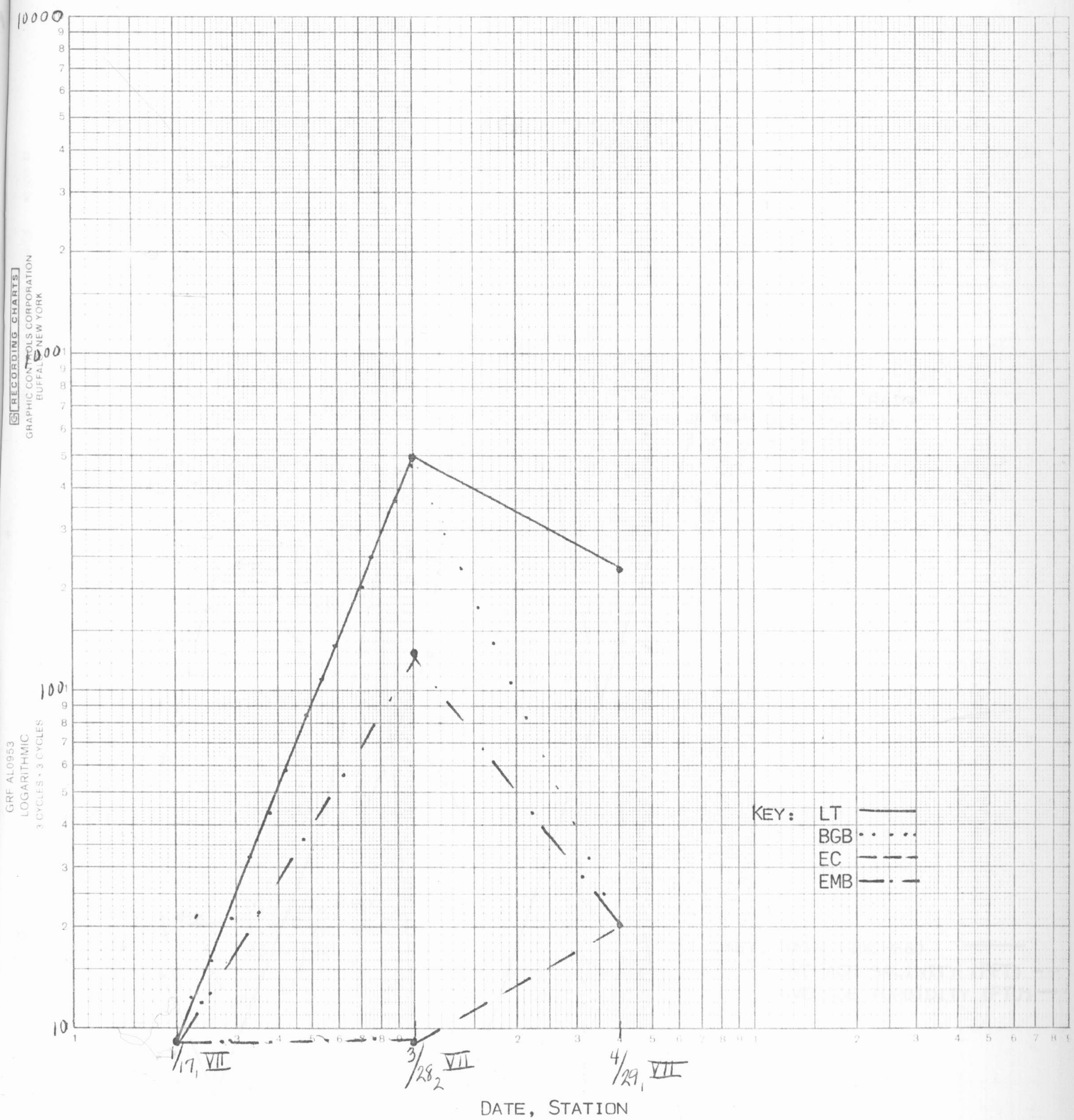


FIGURE 18. BACTERIOLOGICAL ANALYSES, JANUARY 1981 - APRIL 1981
SNEADS FERRY

FIGURE 19. RAIN, SALINITY, AND TURBIDITY FROM NOVEMBER 1980 TO MAY 1981.

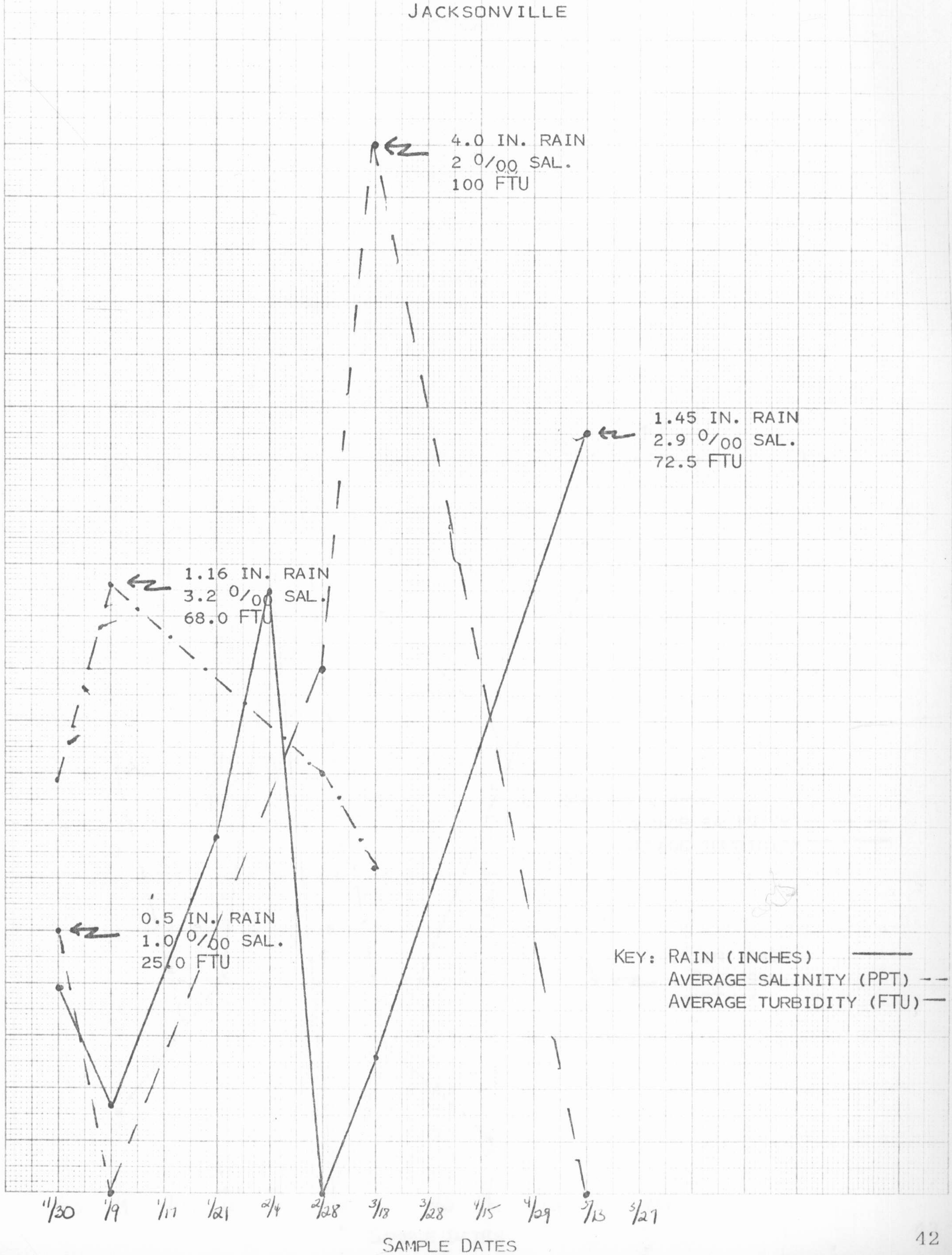


FIGURE 20. RAIN, SALINITY AND TURBIDITY FROM NOVEMBER 1980 TO MAY 1981.

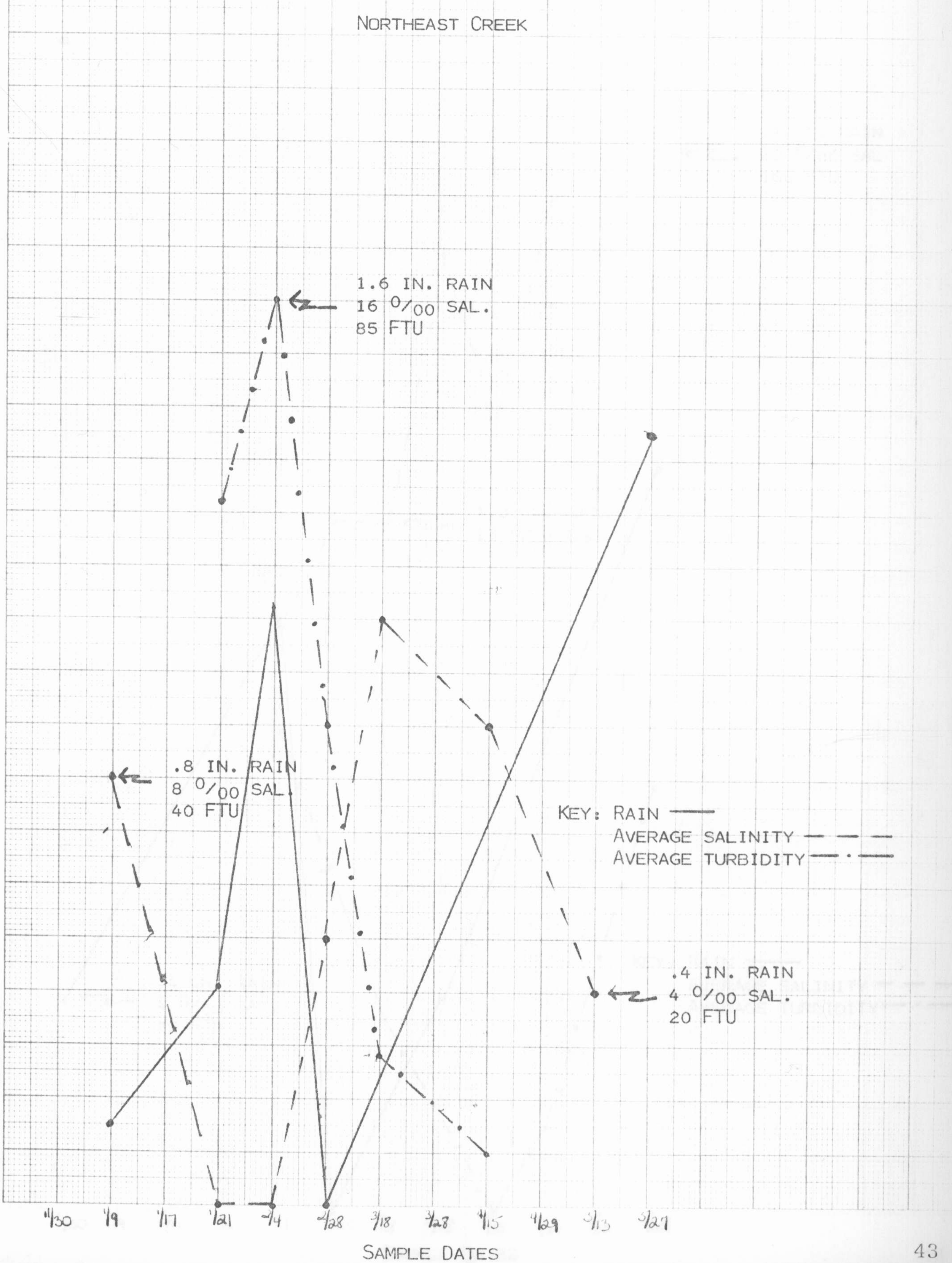


FIGURE 21. RAIN, SALINITY AND TURBIDITY FROM NOVEMBER 1980 TO MAY 1981.

MORGAN-FARNELL BAY

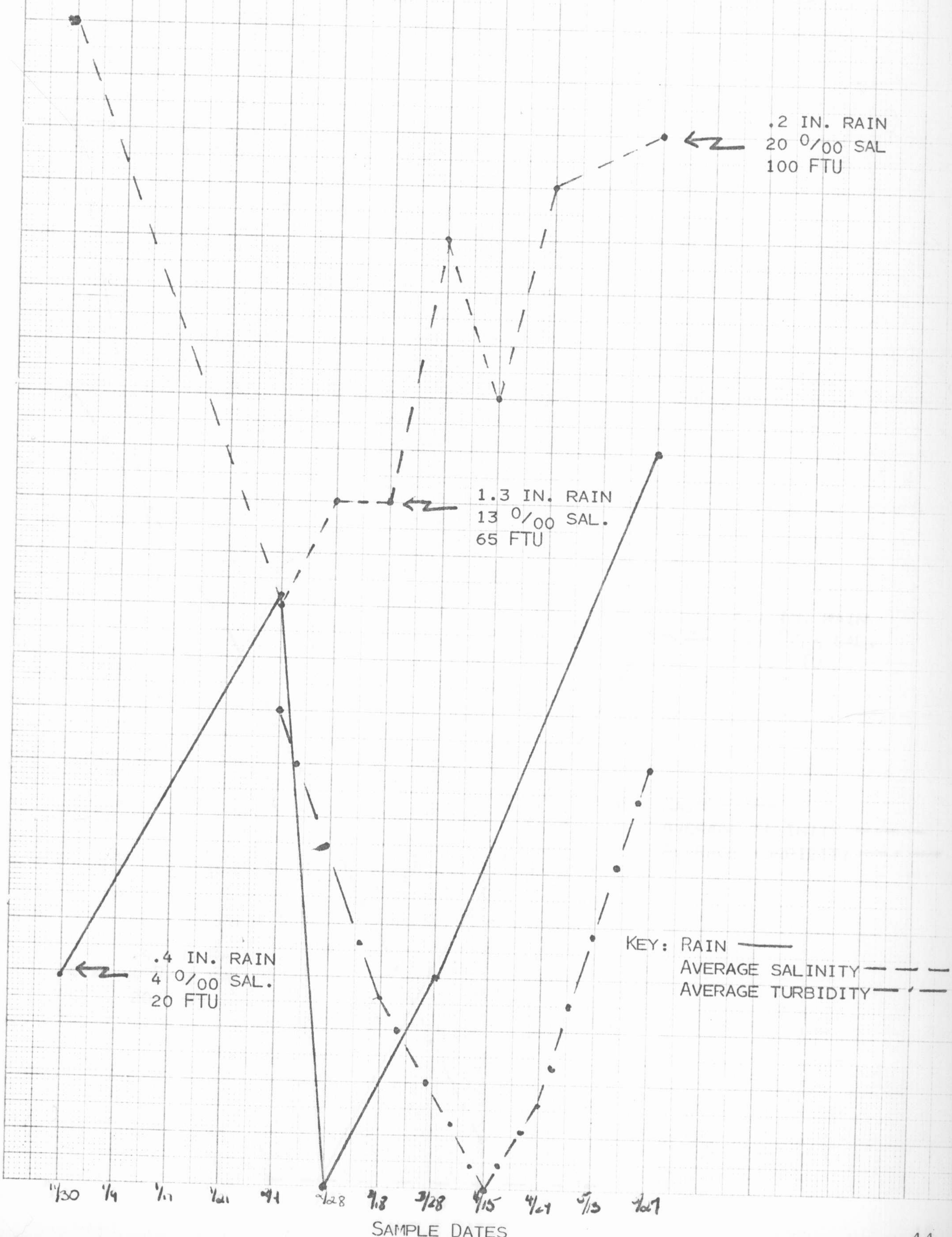


FIGURE 22. RAIN, SALINITY AND TURBIDITY FROM NOVEMBER 1980 TO MAY 1981.

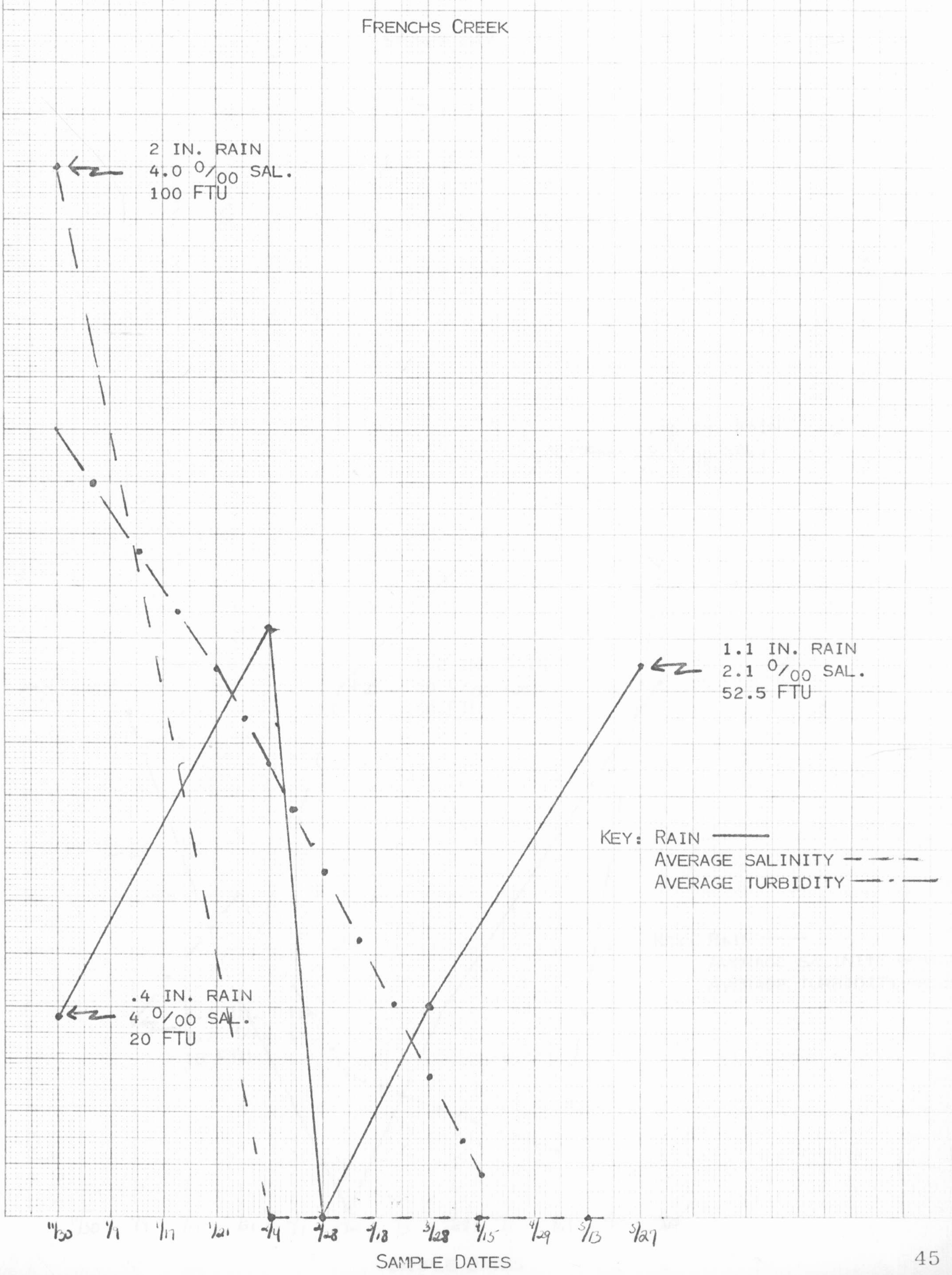
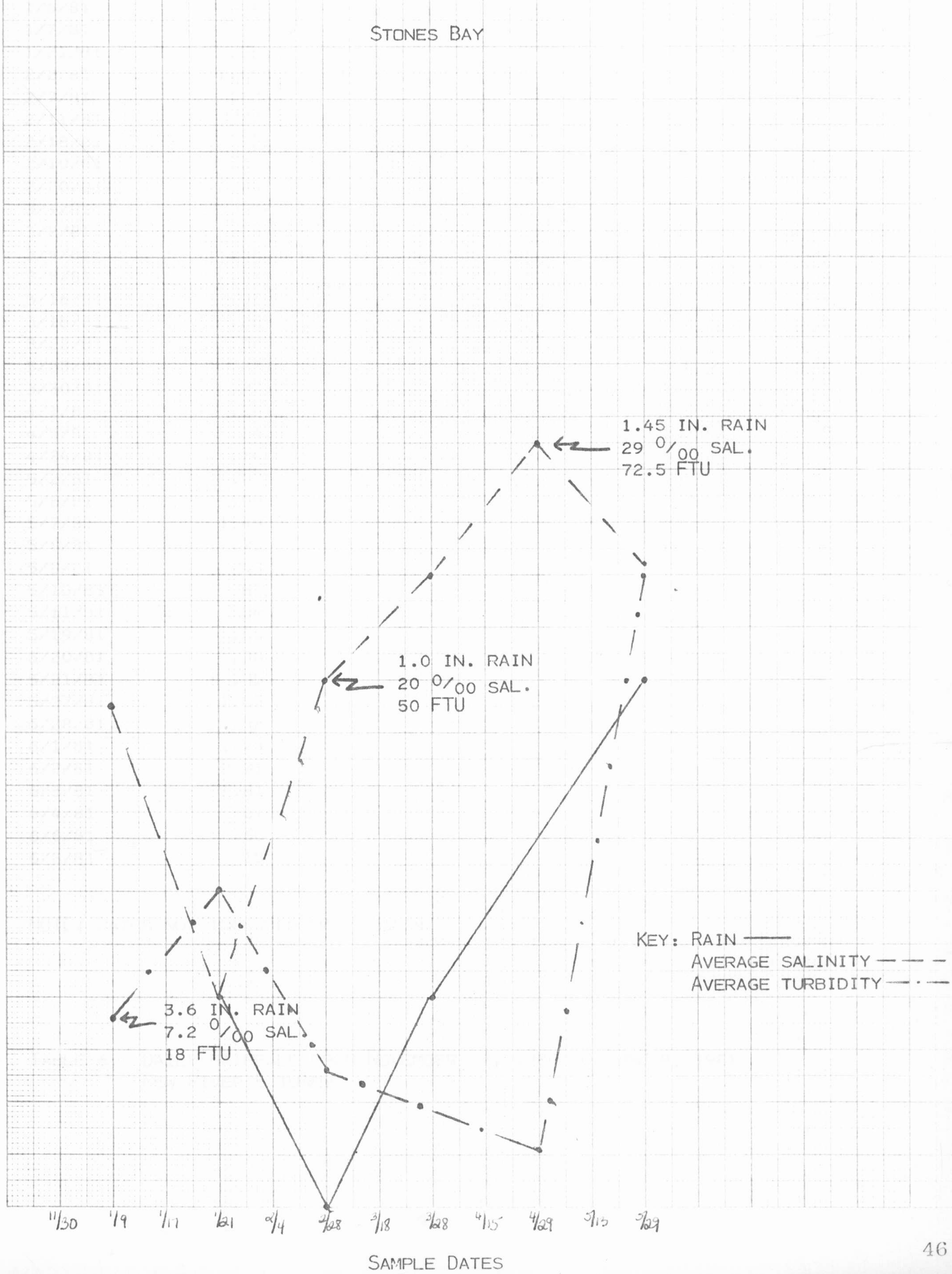


FIGURE 23. RAIN, SALINITY AND TURBIDITY FROM NOVEMBER 1980 TO MAY 1981.



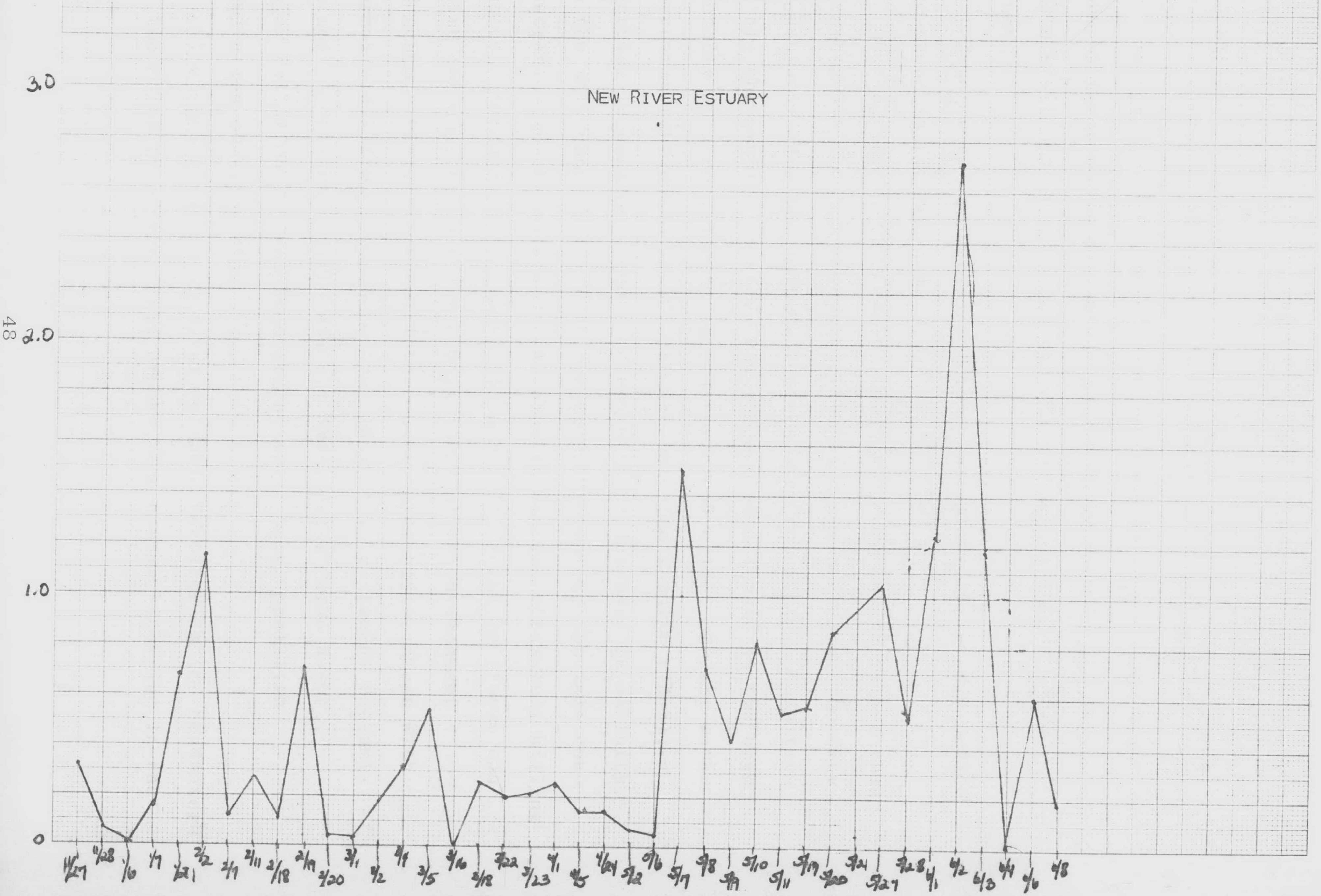
RAIN

11/27/80	.32
11/18/80	.07
1/6/81	.01
1/7/81	.16
1/21/81	.68
2/2/81	1.15
2/7/81	.12
2/11/81	.27
2/18/81	.11
2/19/81	.07
2/20/81	.04
3/1/81	.03
3/2/81	.18
3/4/81	.32
3/5/81	.54
3/16/81	.01
3/18/81	.25
3/22/81	.02
3/23/81	.21
3/30/81	.27
4/1/81	.25
4/5/81	.14
4/24/81	.14
5/2/81	.07
5/6/81	.05
5/7/81	1.49
5/8/81	.71
5/9/81	.43
5/10/81	.81
5/11/81	.54
5/19/81	.56
5/20/81	.86
5/21/81	.05
5/27/81	1.05
5/28/81	.52
6/1/81	1.24
6/2/81	2.71
6/3/81	1.81
6/4/81	.01
6/6/81	.60
6/8/81	.18

NOTE: DATES NOT INCLUDED HAD 0 RAIN

TABLE 6. DAILY RAINFALL FROM NOVEMBER 27, 1980 TO JUNE 8, 1981
NEW RIVER ESTUARY

FIGURE 24. RAINFALL FROM NOVEMBER 27, 1980 TO JUNE 8, 1981



DISCUSSION

The major goals of this project were to assess the coliform bacteria distribution in the New River Estuary and to demonstrate seasonal and geographic changes in the coliform counts.

Total coliform bacteria levels throughout the sample period are shown in Figures 1-4.

During the winter season, total coliform levels higher than permissable for EPA acceptable limits occurred around the City of Jacksonville, the Northeast creek area and in the headwaters of all the smaller creeks. Lower acceptable levels in the bays, probably as a response to the bactericidal effect of salt water intrusion (Rheinheimer, 1971). According to Reddish (1957), a decrease in coliform counts occurs with an increase in salinity. As the salt concentration in the water increases, the salt concentration in the coliform cell also increases, ultimately killing the cell through plasmolysis. As a result, fecal coliforms can exist for no more than three days in a saline environment (Ketchum, 1952). High coliform counts in estuarine areas with normal tidal flow are, therefore, indicative of recent contamination (Amer. Pub. Health Assoc., Amer. Water Works Assoc., Water Pollution Control Federation, 1971; N. C. Shellfish Sanitation Dept., 1981).

The spring maxima in total coliform occurred in the headwaters of the majority of the small creeks, the minima occurring in the

DISCUSSION

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As the salt [illegible]

centration [illegible]

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exist for no [illegible]

(Ketchum, [illegible]

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nation (Amer[illegible]

Water Pollution [illegible]

Sanitation [illegible]

The [illegible]

of the majority [illegible]

bay. One notable instance during the spring sampling occurred on March 13, 1981. Areas sampled around Jacksonville all exhibited low fecal coliform counts with the exception of the area near the sewage treatment outfall. However, every area around Jacksonville had returned to high counts by May 13, 1981. This incidence of low counts is probably attributable to a salt water intrusion into the fresher water surrounding Jacksonville. (Ketchum, 1952; Rheinheimer, 1971; Reddish, 1957).

SEWAGE OUTFALLS

Factors such as salinity, turbidity, rainfall and sewage outfalls had been anticipated to be the major causes of the high coliform counts in the river.

The outfalls in the New River have been examined (Figure 1, station numbers 35 and 38; Figure 2, numbers 8, 13, 15, 35; Figure 3, numbers 6, 18, 33; Figure 4, numbers 6, 38). Total coliform counts were below the legal limit of 79 MPN (EPA, 1978) in all of the outfalls except the Jacksonville plant. In this area, total coliform counts were notably higher than any of the other outfall areas. An examination of this plant's effluent quality is suggested.

Since data indicate that the outfalls are not the probable primary source of total coliform numbers in the river, other sources are perceived as contributing significantly to those counts. These include rainfall runoff, septic seepage and sanitary landfills.

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near the [illegible]

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SEWAGE OUT[illegible]

Factor[illegible]

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The outfalls [illegible]

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Figure 3, number[illegible] Total

coliform counts [illegible] 1978

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All of the discharge systems that were tested were found at acceptable levels (less than 79 MPN), except for the main treatment plant in Jacksonville. The new Jacksonville 201 facility appeared to be the sole outfall contributor of high levels of coliform pollutants, with MPN's ranging from 170 to 330. It may be that the plant cannot process the amount of waste generated by the current population or that secondary treatment plants with chlorination for large urban areas do not sufficiently remove coliform bacterial.

OTHER SOURCES

Measured salinities were correlated with the total coliform and fecal coliform numbers found at stations throughout the estuary. These coefficient values were extremely low ($R=-0.65$ to 0.61, $df=3$), indicating a relationship probably does not generally exist between salinity and coliform counts. Similarly, low value for correlation coefficients between turbidity, total coliform and fecal coliform numbers were obtained ($R=-0.64$ to 0.62, $df=3$), suggesting no relationship between these variables.

Rainfall, on the other hand, showed a high correlation coefficient value with the average total and fecal coliform counts ($R=.61 - .65$, $df=10$). At the 95% level of confidence, the data suggested that a relationship exists between these variables.

It is likely that agricultural use, extensive forest land, and the presence of Camp Lejeune Marine Base have some effect on bacterial densities in land runoff. Local activities probably

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Rainfall [illegible]

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It is [illegible]

and the presence [illegible]

bacterial densities and runoff [illegible] accounting for such an effect include:

1) U. S. Marine field exercises
2) Extensive deer herds
3) Domestic animals in the agricultural areas

Additionally, increased runoff volume likely occurs as a result of the removal of natural ground cover for construction activities.

SEASONAL AND GEOGRAPHIC CHANGES

Analyzing seasonal changes in bacterial populations in the study area, four distinct conditions emerge:

1) Jacksonville, Southwest Creek, Town Creek and Stones Creek sample sites (Figures 5-8) all occur on the Western side of the river, exhibiting a general pattern of peak bacterial counts in February and May with low counts in January and April.
2) On the Eastern bank of the river, Northeast and Wallace Creeks (Figures 9 & 10) show low total coliform counts in November and January, and rapid increases in February with a gradual decrease to zero in April and a rise again in May.

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3) [illegible]

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the study area [illegible]

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in both May [illegible]
31.5% of the [illegible]

3) Frenchs Creek (Figures 11 & 13) shows a pattern of high total coliform count in November with a decrease in February, a subsequent rise in March and a drop-off in April.

4) Stations in the center of the river (Figures 14 to 18) are distinguishable from the other three areas by the lack of a related peak-valley pattern.

These distinct areas can serve to divide the river into four geographic zones:

1) The West bank
2) The Northeast bank
3) The Southeast bank
4) A mediating center zone

SOCIO-ECONOMIC CONSEQUENCES

The New River estuary has been used extensively for recreational boating, crabbing and fishing, and as the local population increases, recreational use of the area will also likely increase. More than 20,000 people per year use the Camp Lejeune Marina alone; based upon a recent Jacksonville survey, which has been accepted as representative of Onslow County (Horace Mann, 1981), at least 14% of the population is involved in boating and another 12.5% would like to do so. Additionally, 34.5% of the population of Jacksonville actively

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3) The [illegible]
4) A [illegible]

SOCIO-ECONOMIC [illegible]

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population increase [illegible]
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Lejeune Marine [illegible]
which has been [illegible]
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in boating and [illegible] Additionally
34.5% of the population [illegible]

fish on the New River, with an additional 14.3% desiring to do so. Finally, seafood harvesting and processing industries add approximately $10,000,000 to the economy of Onslow County (CAMA, 1980).

Any increase in the present high bacterial levels, and in fact, the present level of contamination, is anticipated to be detrimental to recreational and commercial uses of the New River. For example, during the last part of April, 1981, the river was closed to human immersion, fishing and crabbing by order of the N. C. Shellfish Sanitation Dept., resulting in decreased public spending for recreational activities and loss of income to local commercial fishermen.

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CONCLUSIONS AND RECOMMENDATIONS

Analysis of field and laboratory data on bacteriological contamination of the New River, Onslow County, N. C. has led to the following conclusions:

1) Unacceptable total coliform and fecal coliform counts appear to be concentrated in the Jacksonville City area of the New River and in Northeast, Frenchs, Stones, Town, Southeast, and Mill Creeks.
2) The only point source of contamination identified was the Jacksonville 201 sewage facility; non-point sources were numerous and attributable to some form of runoff from agricultural pastures, sanitary landfills and septic tank seepage.
3) Four geographic zones of bacteriological distribution in the New River estuary were identified:
    A) West bank of river
    B) Northeast bank
    C) Southeast bank
    C) Middle of river

    Each zone demonstrated distinctive seasonal patterns of coliform distribution.
4) Increasing the counts of coliform bacteria will probably prove detrimental to recreational and

commercial use of the New River watershed area, while decreased counts will tend to benefit its socio-economic growth and stability.

The following recommendations are proposed as an aid to County planning and public health service:

1) Growths in human population should be accompanied by evaluation of the capability of all existing sewage disposal and septic systems handling wastes.
2) The Jacksonville City 201 facility, in particular, should be evaluated for its present discharge of unacceptable levels of bacteriological contaminants, and necessary measures taken to correct this problem (e.g., tertiary treatment phase).
3) Seepage from septic tanks should be controlled by the prohibition of such tanks except for sites where the water table is suitably below the positioning of such tanks.
4) Existing regulations and ordinances pertaining to bacteriological pollution should be enforced.
5) Watershed consisting of barren land areas should be improved through the implanting of suitable ground cover.

6) Existing sanitary landfills should be evaluated for suitability in waste disposal and enforcement implemented for violations of dumping regulations.

7) Continuing monitoring of coliform levels throughout the New River estuary should be performed, especially with regard to changes occurring in summer and fall, safety for recreational swimming, and definition of the role of non-human (i.e., domestic herd animals and deer) wastes as a bacteriological contaminant.

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LAB ID / INVOICE # EW2375
DATE & TIME COLLECTED 6/9/80
DATE & TIME IN LAB 6/9/80 @ 1:00
COLLECTED BY CUSTOMER

ATTN: GILBERT BANE

SAMPLE DESCRIPTION; WATER PO #209595

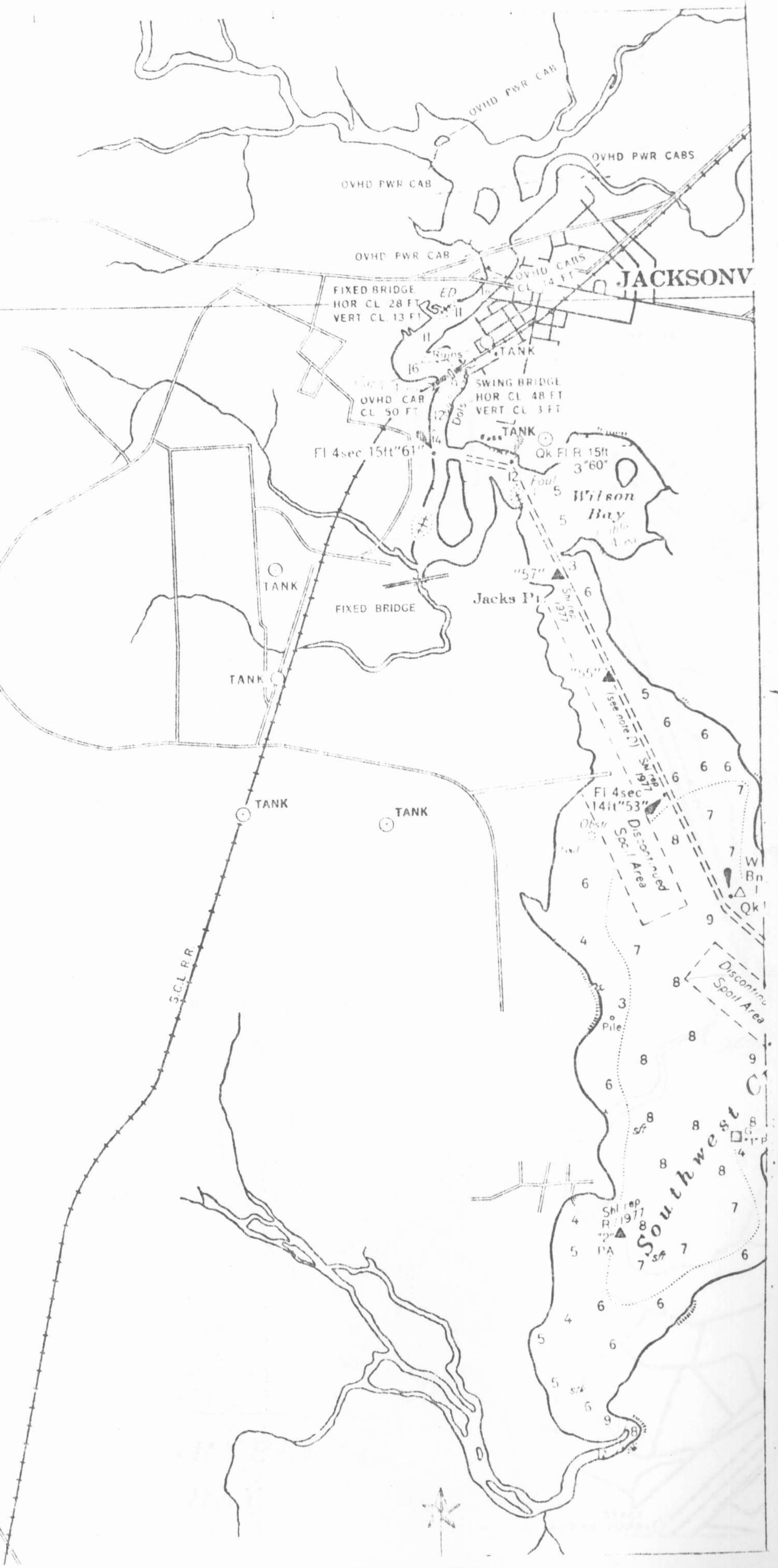
TESTS / SAMPLES	(UNITS)	WATER
COPPER EPA 220.1	PPM	0.044
NICKEL EPA 249.1	PPM	0.008
LEAD EPA 239.1	PPM	0.025
CHROMIUM TOTAL EPA 218.1	PPM	0.005
ZINC EPA 289.1	PPM	0.62
CADMIUM EPA 213.1	PPM	0.002

LABORATORY SUPERVISOR

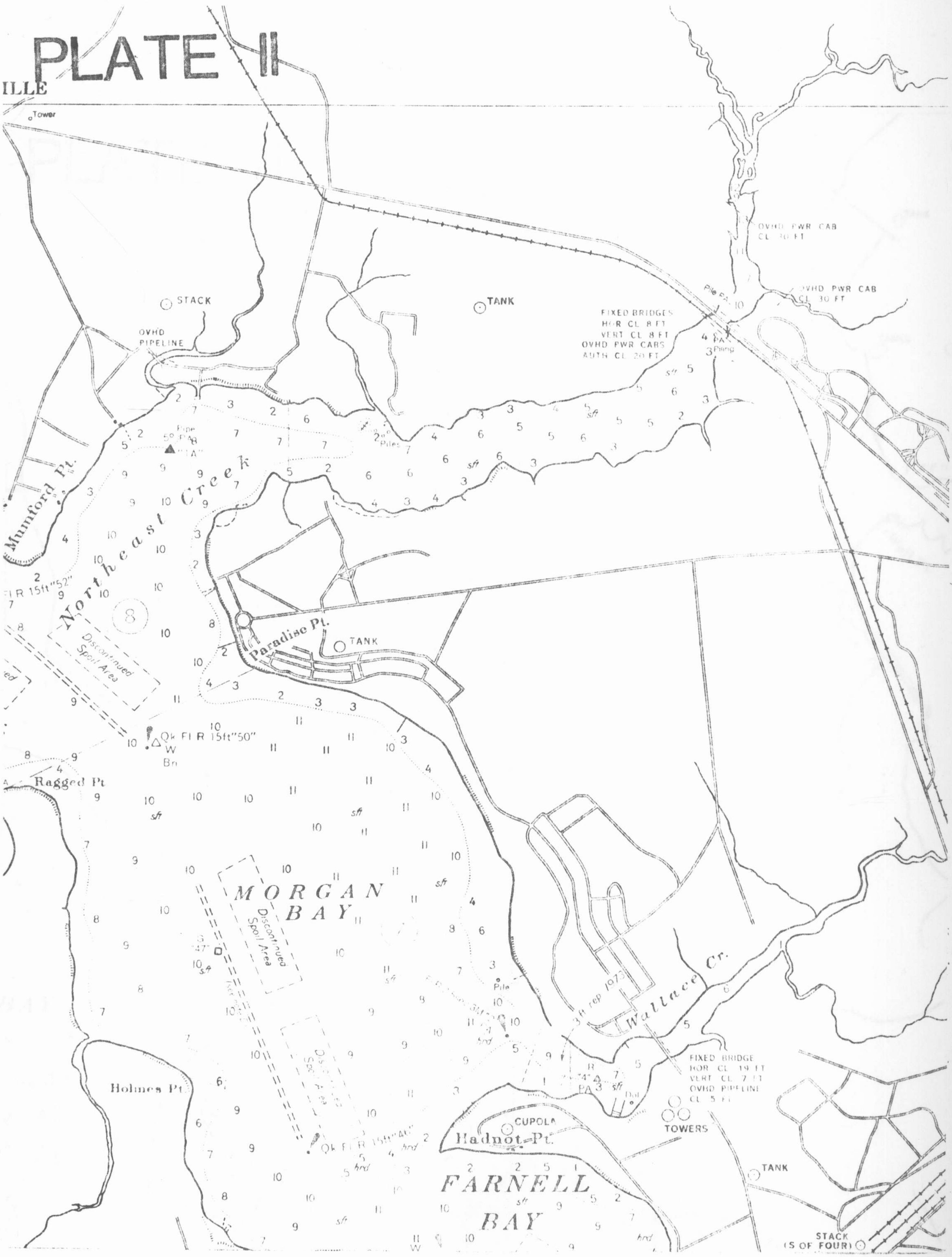
APPENDIX I. RESULTS OF A CHEMICAL ANALYSIS FOR SIX CRITICAL IONS IN THE DISTILLED WATER SUPPLY USED FOR BACTERIOLOGICAL ANALYSES.

APPENDIX 2
SAMPLING MAP PLATE I

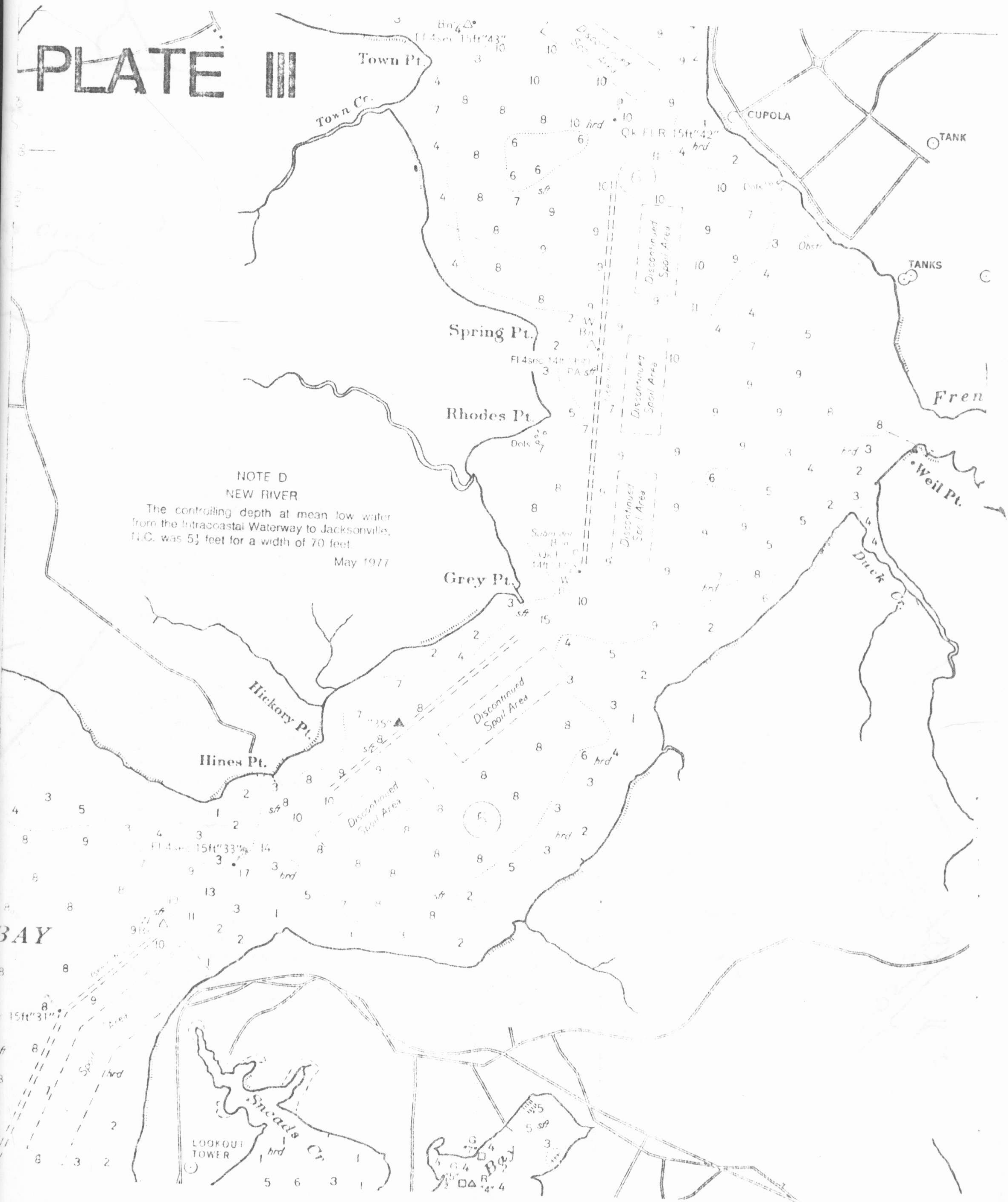
PLATE I



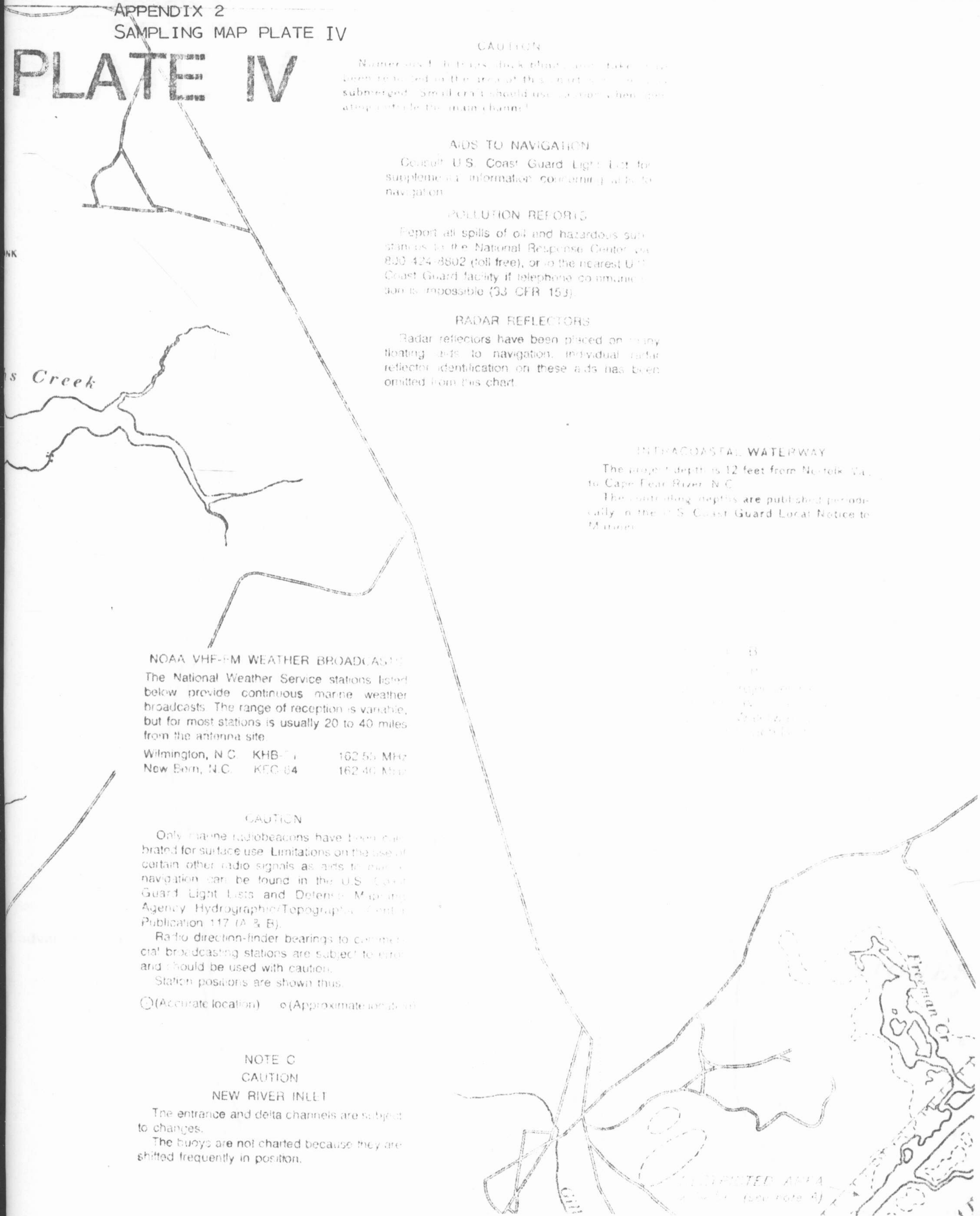
APPENDIX 2
SAMPLING MAP PLATE II



APPENDIX 2
SAMPLING MAP PLATE III

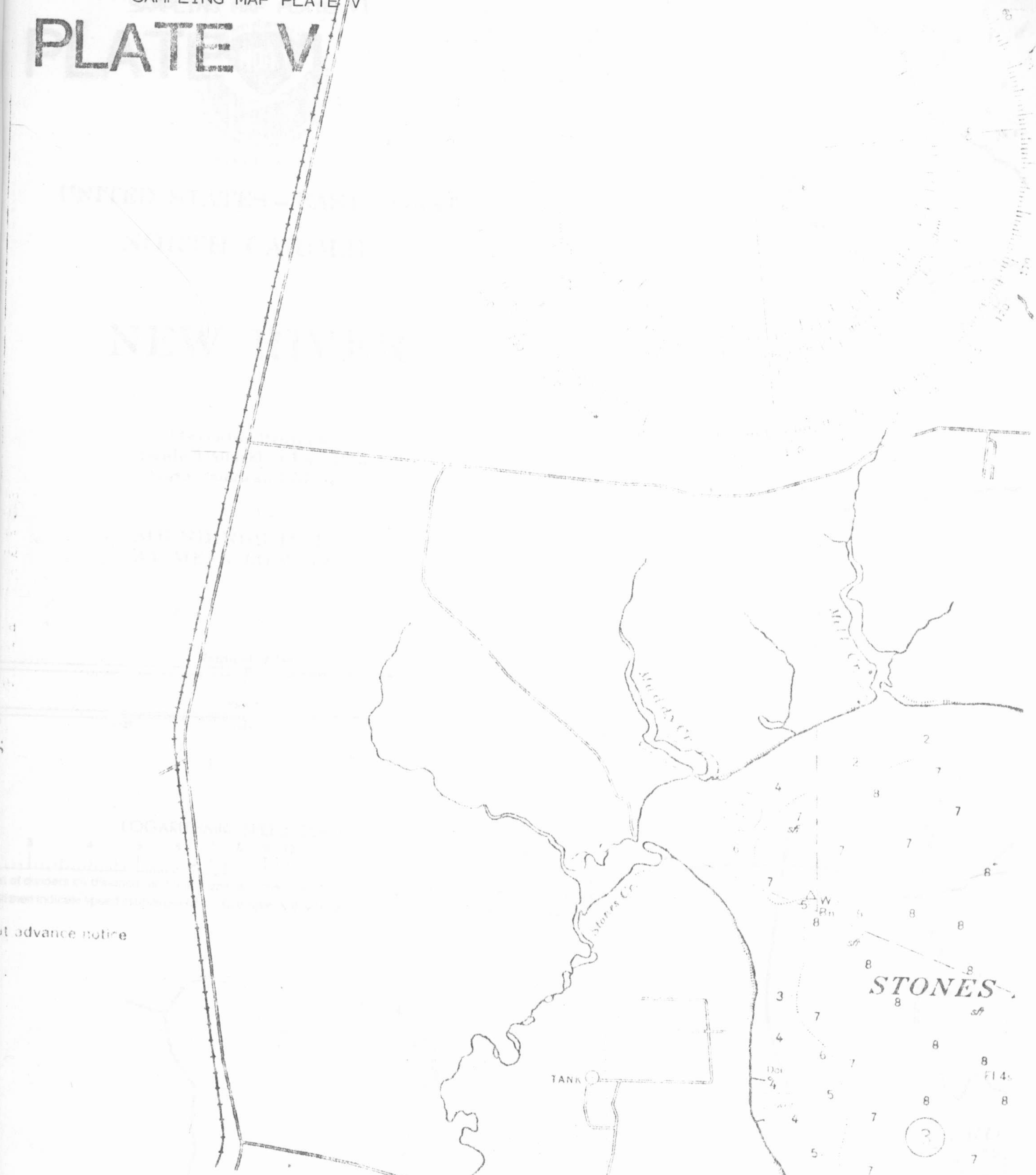


APPENDIX 2
SAMPLING MAP PLATE IV

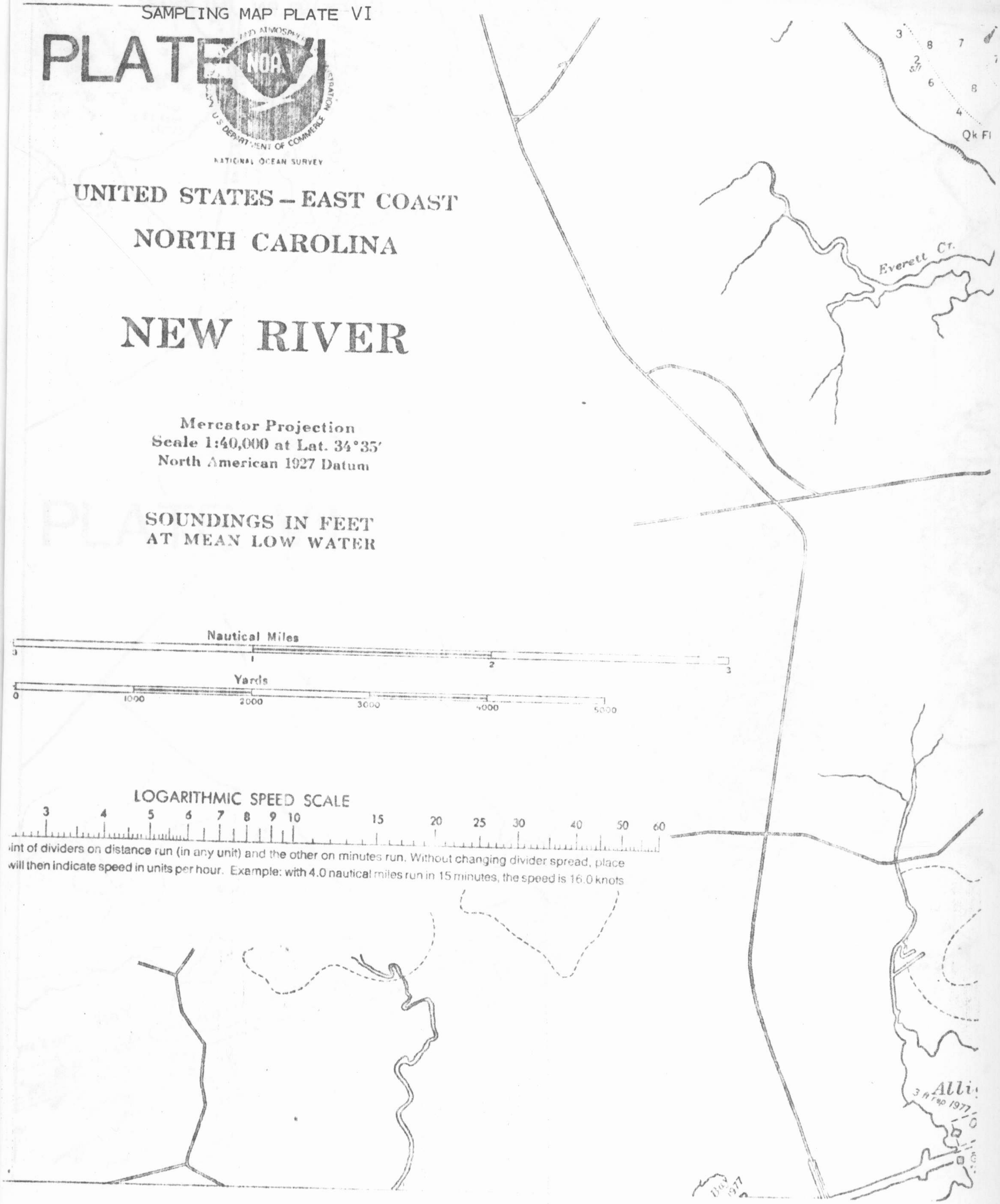


APPENDIX 2
SAMPLING MAP PLATE V

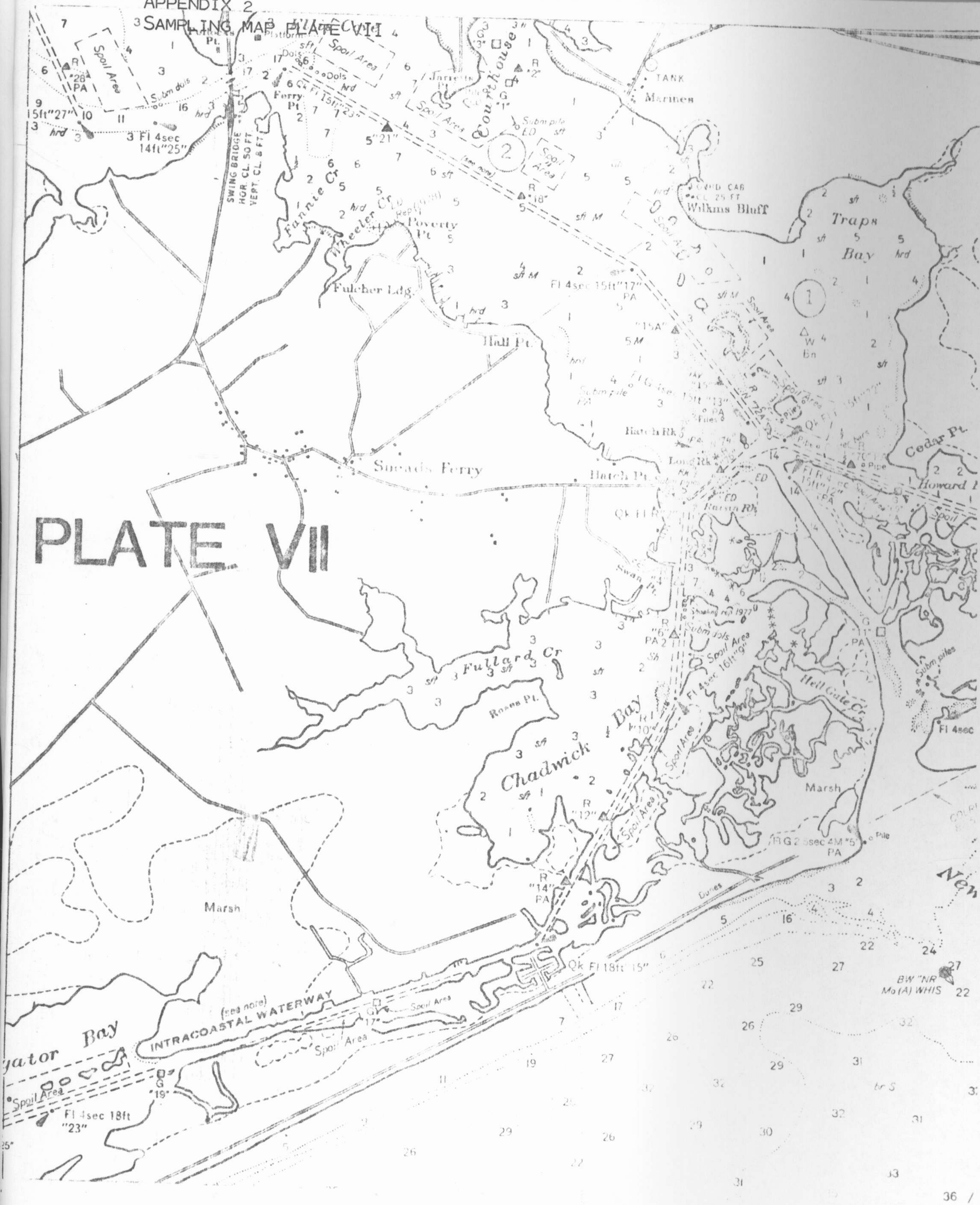
PLATE V



APPENDIX 2
SAMPLING MAP PLATE VI



APPENDIX 2
SAMPLING MAP PLATE VII



PRELIMINARY

BACTERIOLOGICAL ANALYSIS OF THE NEW RIVER ESTUARY

JACKSONVILLE, NORTH CAROLINA

by

Gilbert W. Bane
Director, Environmental Studies

and
Catherine C. Roznowski
University of North Carolina at Wilmington

A Final Research Project Report
to
The Onslow County Planning Department

April 30, 1982

TABLE OF CONTENTS

ABSTRACT

A one year study of the bacteriological quality of the New River Estuary, Jacksonville, North Carolina determined the high coliform levels in the water. The source of these coliforms are predominantly non-human animal origin and from non-point sources. Conclusions result from fecal streptococci to fecal coliform ratios and Pseudomonas aeruginosa results. High fecal and total coliform counts were recorded in peripheral sites such as headwaters of the creeks, near the city of Jacksonville and in Wilson Bay. Low fecal and total counts occur in the mid-water sites of Stones and Farnell Bays as a result of high tidal fluxuation and deeper water. The total and fecal coliform counts increased with rain. Coliform pollution is of economic consequence to residents of Onslow County, since approximately 1000 people use the river on the average of once a month and most are involved in recreational fishing or boating.

[illegible]

estuary, [illegible]

levels [illegible]

non-human [illegible]

from [illegible]

[illegible]

in [illegible]

Jacksonville [illegible]

tide-water [illegible]

fluxuation [illegible]

increases with [illegible]

residents of [illegible]

river on [illegible]

recreational [illegible]

ACKNOWLEDGMENTS

I would like to express my gratitude to the many people who made the successful completion of this project possible. I am deeply indebted to Dr. Gilbert W. Bane, my major professor, for his unceasing encouragement during the difficult times. I would like to thank Cindy Bane, Stoney Black, Peter Colwell, Derik Davis, Lynn Dupree, Joe Eldridge, Mike Jones, Amanda McWatters, Pat Monahan, Stephanie Petter, Brian Phillippi, Carla Sanderson, Terry Walker and Phil Welsh for their help in field and laboratory work.

I am grateful to Ken Windley, Director of Planning for Onslow County and Horace Mann, Director of Planning for Jacksonville, for planning information; James Wooton, Director of Natural Resources and Environmental Affairs Branch and Peter Black, Assistant Forester, for environmental data collected at the Environmental Center of Camp Lejeune Marine Base; and Mrs. Knavel, Camp Lejeune Marina, who provided boat storage space. George Everett supplied reports on septic tanks and pollution in New Hanover County; Bob Benton, Division of Health Services and Shellfish Sanitation Division Chief, for extensive information and prior surveys on oyster bed pollution; Rich Carpenter, Director of Division of Marine Fisheries Research Laboratory at Wrightsville Beach for information on the oyster fishery in the Jacksonville region and Dan Silver who provided a discussion of the sewage treatment facilities and their problems.

I also wish to express my sincere appreciation to Dr. Ronald Sizemore and Dr. David Roye for their beneficial criticism of this manuscript. In addition, thanks are due to the students who helped in

ACKNOWLEDGMENTS

[illegible] who made [illegible] Especially [illegible] [illegible] [illegible] Fiderer, Nikki Jones, Amanda [illegible] Brian Williams, Kasey [illegible] help in field [illegible]

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I [illegible] wish to express my [illegible] Sizemore and Dr. [illegible] for [illegible] of this manuscript. In addition, thanks [illegible] offered.

the discussion of this manuscript, especially Roddy Michalove, Linda Taylor and Floyd Thomas. I am extremely thankful to Maxine Fishero, Rosemarie Parker, Stephanie Reed and the Southeastern Undersea Research Facility's Apple II computer for their assistance in typing the manuscript.

SUMMARY AND RECOMMENDATIONS

During a one year study of the bacteriological quality of the New River Estuary, Jacksonville, North Carolina the coliform levels in the water were determined. Testing was performed according to nationally accepted Standard Methods. The source of these coliforms were predominantly from non-human animals that entered the estuary from non-point sources. Conclusions were based upon fecal streptococci to fecal coliform ratios and Pseudomonas aeruginosa results. High fecal and total coliform counts were recorded in peripheral sites, such as headwaters of the creeks, near the city of Jacksonville and in Wilson Bay. Low fecal and total coliform counts were observed in the mid-water sites of Stones and Farnell Bays. These counts were kept in check by high tidal fluxuations and deeper high salinity water. The total and fecal coliform counts increased directly after rainfall. Coliform pollution is of economic importance Onslow County residents. Approximately 1000 people, involved in recreational fishing and boating, use the river on the average of once a month.

Analysis of field and laboratory data collected during this study led to the following conclusions:

1) High total coliform and fecal coliform counts are concentrated around the populated areas of Jacksonville City and in Northeast Creek, Frenchs Creek and in Wilson Bay.
2) Most coliform counts are from non-point sources and are attributed to run-off from agricultural pastures, wildlife, sanitary landfills and storm drains.
3) Fecal streptococci and Pseudomonas aeruginosa data indicate

that most non-point source coliform pollution is of an animal origin.

4) Seasonal distribution patterns of coliform bacteria showed peaks in February, June and August, due to increased rainfall.

5) Increased coliform bacteria will be detrimental to recreational and commercial use of the New River watershed area, as with more coliforms additional shellfish areas are likely to be closed. Decreased coliform counts tend to benefit the socio-economic growth and stability since more clean areas will provide recreation to county residents.

The following recommendations are proposed as an aid to Onslow County planning and public health services:

1) All new dwellings and businesses should be connected to city or county sewage treatment facilities. All existing septic tanks should be monitored periodically to insure conformation to existing regulation; furthermore a thorough analysis of setback distances and related pollution is recommended.

2) A diffuser pipe to carry off storm drainage and excess runoff should be established from Mumford Point running southeast 500-1000 yards into Morgan Bay. This will dilute bacteria carrying waters and will bring bacteria arising from land excess runoff in contact with higher salinity saltwater with antiseptic results.

3) Future landfills should be isolated on soils suitable to bacterial degradation and which will not otherwise

that would [illegible]

control [illegible]

2) Sed [illegible] to [illegible]

ponds [illegible] [illegible] fall.

3) Increased [illegible]

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The following recommendations [illegible] County

planning and public health [illegible]

1) All new dwellings [illegible] or

or county sewage [illegible] existing [illegible]

tanks should be [illegible]

construction [illegible]

analysis [illegible]

recommended.

2) A buffer [illegible]

runoff [illegible] established [illegible]

southeast [illegible]

dilute [illegible]

wetlands [illegible]

salinity [illegible]

3) Future [illegible] should be [illegible]

to [illegible] degradation and [illegible] burden the existing levels in the bay. The existing landfill on Northeast creek is minimally adequate but during times of heavy rainfall this creek significantly contributes to bacteria in the estuary.

4) The surrounding watershed, consisting of barren land, should be improved through the planting of suitable ground cover, i.e. grass or trees, in order to increase the holding of water in the soil.

5) Wilson Bay is suspect as a health hazard and should be closed to fishing, swimming and boating pending a thorough sediment study.

6) Evaluation of the capability of all existing sewage disposal and septic systems that handle wastes in the county should be initiated to reflect the needs which are anticipate as the population increases.

7) We urge that tests done on suspected pollution in the estuary use analyses appropriate to distinguish between *E. coli* and non-human bacteria which give similar results through standard testing such as fecal streptococci and *Pseudomonas aeruginosa*.

burden [illegible]

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4) The surrounding [illegible]

should be [illegible]

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7) We urge that [illegible]

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INTRODUCTION

The New River Estuary, located in Onslow County, North Carolina, is bordered on the north by Jones County, Duplin County to the west, Carteret County and Onslow Bay on the east and to the south, Pender County. Planners in Onslow County and Jacksonville are presently concerned with the water quality of the New River and its adjacent estuary because of the present and potential use of these waters for boating, swimming, commercial and recreational finfishing and shellfishing. Local sanitary engineers have suggested that the proximity of sewage disposal systems to regional estuaries, the influence of water runoff and the discharges from storm drains and other outflows has added to the bacteriological burden of the bay. Because these waters lie within the urban region dominated by the Camp Lejeune Marine Base, the City of Jacksonville and several other coastal communities, concern for water quality has risen sharply.

Mindful of the potential hazard of coliform bacteria in the estuary, the Onslow County Planning Department has expressed concern about regional water quality. This paper summarizes a 1980-1981 study of water quality of the New River Estuary, Jacksonville, North Carolina. Onslow County's research goals and the goals of this study were 1) to develop a system which would abate the high coliform bacterial levels which presently occur in the river and estuary; 2) to determine specific sources of coliform bacteria; and 3) to assess seasonal changes in the abundance and distribution of coliform bacteria throughout the area. This resultant information will be utilized in decision-making processes affecting recreational and [illegible] is bordered [illegible] County [illegible] Carteret County and [illegible] County. [illegible] concerned with [illegible] estuary because [illegible] boating, swimming, [illegible] shellfishing, [illegible] proximity [illegible] influence of [illegible] and the [illegible] other activities [illegible] Because these [illegible] within the [illegible] LeJeune Marine Base, [illegible] coastal communities, concern [illegible]

Mindful of the potential [illegible] estuary, the Onslow County [illegible] about regional water quality [illegible] of water quality [illegible] New River [illegible] North Carolina. Onslow County's research [illegible] were 1) to develop [illegible] bacterial levels which presently [illegible] determine specific sources of coliform [illegible] seasonal changes in the abundance [illegible] bacteria throughout the area [illegible] utilized in decision-making [illegible] commercial land use.

This study was funded by Onslow County, the City of Jacksonville and North Carolina Department of Natural Resources and Community Development through the Office of Coastal Zone Management (grant number: 2984-80-0043) awarded to the University of North Carolina at Wilmington on November 10, 1980. The principle investigator was Dr. Gilbert W. Bane.

The specific objectives of the funded study are:

1) To assess the coliform distribution in the waters of the New River adjacent to the City of Jacksonville and around the shores of Camp Lejeune Marine Base

2) To define point and non-point sources of pollution in the estuary

3) To demonstrate seasonal and geographic changes in coliform counts in the New River Estuary as an indicator of pollution

4) To present information on the economic consequences of coliform pollution to the residents of Onslow County

5) To evaluate and define appropriate alternatives to the present discharge system.

The research reported in this thesis emphasizes objectives 1,2 and 3. Objectives 4 and 5 were used as supplemental material to show the signifigance of scientific data.

commercial land use.

This study was [illegible] Jacksonville and North Carolina [illegible] Development through [illegible] number: 2984-80-[illegible] Wilmington on November [illegible] 198[illegible] Gilbert W. Banes.

The specific [illegible]

1) To assess the [illegible] the [illegible] Jacksonville [illegible] base.

2) To define [illegible] in the [illegible]

3) To demonstrate [illegible] coliform counts in the [illegible] as an indicator of [illegible]

4) To present information [illegible] these coliform pollution [illegible]

5) To [illegible] and [illegible] to the present discharge [illegible]

The research [illegible] objectives [illegible] and 3. Objectives [illegible] the significance of [illegible] data.

LITERATURE REVIEW

Indicator Organisms

Indicator organisms are associated with the intestinal tract, and their presence in water indicate that the water has received contamination of an intestinal origin. The coliform group of organisms are suitable as indicators because they are common inhabitants of the intestinal tract of humans and other warm-blooded animals and are generally present in the intestinal tract in large numbers. When present in the water environment, the coliform organisms eventually decrease in number (Dawe & Penrose, 1978), but at rates no faster than the pathogenic bacteria, Salmonella and Shigella. Both the coliforms and the pathogens behave similarly during water purification processes (Brock, 1979).

The detection of enteric bacteria, specifically in the Escherichia, Enterobacter, Shigella and Salmonella groups, is not necessarily a statement of safety within the water tested, but serves as a warning signal of potential pathogen presence (Pelczar and Reid, 1972). Thus, coliforms have become the accepted standard for water and shellfish marketability for the U.S. Food and Drug Administration.

Despite significant advancements in the fields of medicine and sanitation, fecal coliform groups continue to create health problems, largely attributable to increased urbanization and the increasing use of broad spectrum antibiotics. Increased population density invariably results in expanded sewage outflow, most commonly in this

[illegible]

Indicator [illegible]

Indicator [illegible] their presence [illegible] contamination [illegible] organisms are [illegible] inhabitants [illegible] animals [illegible] numbers. [illegible] organisms [illegible] rates [illegible] Both [illegible] purification [illegible].

The detection of [illegible] *Escherichia*, *Enterobacter*, *Klebsiella* [illegible] necessarily [illegible] serves as a warning signal of potential [illegible] and Geld, 1972). Thus, [illegible] have been [illegible] and shellfish [illegible] quality [illegible].

Despite [illegible] advances [illegible] sanitation, [illegible] groups [illegible] problems, largely attributed to increased [illegible] of broad spectrum [illegible] invariably result [illegible] expanded [illegible] area into septic tank systems that drain into adjacent lands. The use of antibiotics in relation to the waste disposal problems was addressed by Alexander (1971). He concluded that these antibiotics make possible diseases caused by normally docile strains of Staphlococcus, Proteus and Pseudomonas by eliminating normal bacterial flora.

Wastes from sewage and septic systems, storm drainage and farmland runoff can enter recreational waters. Care must be taken to prevent excessive coliform loads in these waters because they can threaten public health and safety.

Viruses can also be utilized as indicators of fecal pollution since they infect the gastrointestinal tract of man and are excreted with the feces of infected individuals. These viruses are present in domestic sewage which, after various degrees of treatment, enter waterways that serve as a source of water for most large communities. The viruses known to be excreted in relatively large numbers with feces include polioviruses, coxsackieviruses, echoviruses, adenoviruses, reoviruses and the virus of infectious hepatitus (Clark, et. al., 1962 and 1964).

Infections with poliomyelitis virus have been associated with fecally polluted water. Polioviruses are particularily evident during the summer in city sewage. Other viral infections are more frequently associated with the ingestion of polluted water, again particularly in summer. Outbreaks occur repeatedly in individuals using polluted outdoor swimming pools. A common cause of these infections are coxsackie and echoviruses which are regularly found in sewage during the warm season of the year. Certain hepatitis viruses are also [illegible]tes into septic tank [illegible] the use of antibiotics in [illegible] to the [illegible] addressed by Alexander [illegible] possible diseases caused [illegible] *[illegible]phylococcus*, *Proteus* and [illegible] [illegible]ota.

Wastes from sewage [illegible] farmland runoff can [illegible] prevent excessive coliform [illegible] threaten public health and safety.

Viruses can also be [illegible] since they infect the gastro[illegible] the feces of infected [illegible] domestic sewage which, after various [illegible] streams that serve as a source of [illegible] viruses known to be excreted [illegible] include polioviruses, coxsackieviruses, [illegible]viruses, reoviruses and the virus of [illegible] [illegible]l., 1962 and 1966).

[illegible] infections with poliomyelitis [illegible] polluted water. Polioviruses are [illegible] during [illegible] summer in city sewage. Other [illegible] [illegible]ated with the ingestion of polluted [illegible] particularly in [illegible]. Outbreaks occur repeatedly in [illegible] polluted [illegible] swimming pools. A common [illegible] are [illegible] and echoviruses which are regularly [illegible] during [illegible] season of the year. Certain hepatitis [illegible] associated with polluted water and increases in the colder months (Rheinheimer, 1976).

Sewage treatment, dilution, natural inactivation and water treatment reduce viral numbers from treated waters before that water is supplied for domestic purposes. Large outbreaks of waterborne viral diseases may occur with massive sewage contamination of a water supply. In technologically advanced nations, viral infection and disease are reduced because waste treatment while not completely eliminating pathogenic viruses, decreases their number so that they do not produce infection. (Clarke, et. al., 1962 and 1964.)

Of major importance in the evaluation of water quality is the study of coliform bacteria extant in these waters. As defined by the American Public Health Association (APHA) (1975), the coliform group comprises "bacteria that are aerobic or facultative anaerobic, gram negative, non-spore forming and rod-shaped, that ferment lactose with gas formation within 48 hours at 35° C". *Escherichia coli*, a common intestinal organism, *Klebsiella pneumonia*, a less common intestinal organism and *Enterobacter aerogenes*, an organism not associated with the intestine, currently comprise the coliform group (Brock, 1979). The coliform group can be broken into two components, fecal and nonfecal. Fecal coliform bacteria are found in the fecal matter of all higher animals, including humans and are usually introduced into the water column by septic seepage, sewage outfalls and land runoff. By APHA defination, "fecal coliforms are those that ferment lactose with gas formation in a suitable culture medium in 24 hours at 44.5° C. This differentiation can yield valuable information concerning the possible source of pollution in the water and especially the distance

from the source of this pollution. This is possible because the nonfecal members of the coliform group may be expected to survive longer than the fecal members in the unfavorable environment provided by the water (Standard Methods, 1975).

Coliform bacteria can be enumerated using the Multiple-tube Fermentation Technique from Standard Methods for Examination of Water and Wastewater. This technique consists of two parts:

1) The Standard Methods technique for total coliform distribution
   a) Presumptive Test
   b) Confirmed Test
   c) Completed Test
2) The Standard Methods technique for fecal coliform detection
   a) Presumptive Test
   b) Fecal Coliform Test

Each test produces a value, the Most Probable Number (MPN), which is not an actual enumeration of the coliform bacteria, but merely an index of the number of coliform bacteria that, more probably than any other number would give the results shown by the laboratory examination (Standard Methods, 1975). The MPN is a theoretical value determined by statisticians and an example is given in the table in MICROBIOLOGICAL METHODS FOR MONITORING THE ENVIRONMENT: WATER AND WASTES(1978).

The importance of fecal coliform bacteria in water quality study lies in their usefulness as an indicator organism for many pathogenic microorganisms (Wyss and Eklund, 1971; American Water Works Association and Water Pollution Control Federation, 1971; Wheeler and from the source of [illegible] it is [illegible] [illegible]

nonfecal members of the coliform [illegible] [illegible]

longer than the fecal [illegible] [illegible]

by the water (Standard Methods, [illegible]).

Coliform bacteria [illegible] [illegible]

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and Wastewater. These [illegible] [illegible]

1) The Standard Methods [illegible] [illegible]

distribution [illegible]

a) Presumptive Test

b) Confirmed Test

c) Completed Test

2) The Standard Methods [illegible] [illegible]

a) Presumptive Test

b) Fecal Coliform Test

Each test produces a value, the [illegible] Probable Number (MPN), which is not an actual enumeration of the coliform bacteria, but only an index of the number of coliform [illegible] [illegible] than any other number would give the results [illegible] examination (Standard Methods, 1971). The [illegible] value determined by statistical [illegible] in the [illegible] MICROBIOLOGICAL METHODS FOR MONITORING THE ENVIRONMENT [illegible] WASTES(1978).

The importance of fecal coliform bacteria [illegible] lies in their usefulness as an indicator organism for [illegible] pathogenic microorganisms (Wyss and Eklund, 19[illegible]; American [illegible] Association and Water Pollution Control Federation, [illegible]) [illegible]

Volk, 1964). Table 1 lists pathogenic organisms in the United States for which the coliform bacteria, Escherichia coli is an indicator.

Faust (1976) examined the coliform pollution from land runoff to a stream that entered the Chesapeake Bay. She determined that the fecal coliform discharge rate from this land was seasonal and largely dependent on water flow. The total coliforms were influenced by the same factors. Fecal coliforms persisted in the water; numbers were high in the Rhode River close to discharge points; further away they were diluted out by the river volume. Bacterial persistence at low winter water temperatures in the estuary increases bacterial numbers and apparent pollution levels. This was considered to be the explanation for the high fecal coliform levels in the estuary.

Dilution was observed to be the major influence on fecal coliform counts in the River Lagan Estuary, Northern Ireland, U.K. The fecal coliform counts were found to decrease with increasing river depth (Parker, et.al., 1979).

The presence of coliforms in the water column allows for the development of modeling systems. Kelch and Lee (1978) developed a computer-assisted, multiple linear regression analysis program to predict the fecal coliform levels in the estuarine environment. They used data collected by isolating fecal coliforms on Millepore HAWG membranes and examining their resistance to 12 antibiotics. A total of 135 independent variables were analyzed to determine their correlations with two dependent variables - bay fecal coliform count and log bay fecal coliform count. Relationships were noted between these dependent variables and ambient temperature, precipitation, recreational use of the tributaries, antibiotic resistance levels and olk, 1964). [illegible] which the coliform [illegible]

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TABLE 1

Pathogenic Organisms for which *Escherichia coli* is an indicator.

	ORGANISM*	DISEASE
Bacteria	*Salmonella typhi*	Typhoid Fever
	Vibrio cholerae	Cholera
	Shigella sp.	Shigellosis
	Salmonella paratyphi	Salmonellosis
	Escherichia coli (pathogenic strains)	Gastroenteritis
	Leptospira sp.	Leptospirosis
	Francescilla tularensis	Tularemia
Viral	Hepatitis A Virus	Infectious hepatitis
	Polio Virus	Polimyelitis

*These organisms have been in epidemic proportion in the U.S. (1946-1975) (Brock, 1979).

[illegible]

...ogenic Organisms for which [illegible]

ORGANISM	[illegible]
Salmonella [illegible]	[illegible]
Vibrio cholerae	[illegible]
Shigella sp.	[illegible]
Salmonella [illegible]	[illegible]
Escherichia coli (pathogenic strains)	[illegible]
Leptospira sp.	[illegible]
Entamoeba histolytica	[illegible]
Hepatitis A Virus	Infectious Hepatitis
Polio Virus	Poliomyelitis

...these organisms have been [illegible]

..., 1979).

fecal counts in the tributaries.

Fecal Streptococci

The normal habitat of fecal streptococci is the intestine of man and animals; thus, these organisms are additional indicators of fecal pollution. Counts of fecal streptococci provide valuable supplementary data on the bacteriological quality of lakes, streams and estuaries, because streptococci persists longer and are better indicators than coliforms for past pollution. However, most valuable application of the fecal streptococci test is the determination of ratios of fecal coliform to fecal streptococci. Because coliform predominates over streptococci in human feces, ratios of 4.0 or higher typically indicate domestic waste while ratios of 0.6 or lower indicate discharge from farm animals or storm water runoff. (Standard Methods, 1975). Gore and co-workers (1979) examined fecal coliform: fecal streptococci ratios in the Cochin (India) backwaters. The ratio indicated that the principle source of fecal pollution is nonhuman type originating from land drainage, discharge of organic waste and sewage discharge.

Pseudomonas aeruginosa

According to Standard Methods (1975), *Pseudomonas aeruginosa* is important in recreational waters because it is an "opportunistic" human pathogen which may multiply in recreational waters in the presence of sufficient nutrients. Its enumeration is valuable because it may indicate the discharge of nutritive wastes into receiving waters. Cabelli and co-workers (1976) examined the relationship of *P.*

fecal counts in the … stations.

Fecal Streptococci

The normal habitat of fecal streptococci is the intestines of humans and animals; thus, these organisms … pollution. Counts of fecal streptococci … supplementary data … and estuaries, because … indicators than … application of the fecal … ratios of fecal coliform to fecal streptococci … predominates over … typically indicate domestic … indicate discharge from farm … Methods, 1975). … fecal streptococci ratios … indicated that the principle source … type origination from land drainage … sewage discharge.

Pseudomonas aeruginosa

According to Standard Methods (1975), *Pseudomonas aeruginosa* is important in recreational water because it is a … human pathogen which may multiply in … presence of sufficient nutrients … It may indicate the discharge of … waters. Cabelli and [illegible] (1975) …

aeruginosa levels to fecal coliform densities in estuarine and fresh recreational waters at varying distances from known pollution sources in Lake Michigan. They showed that P. aeruginosa may indicate pollution of recreational waters by human wastes, especially where the probability of bacterial multiplication is minimal. High fecal coliform densities coincident with low P. aeruginosa levels suggest that the source of fecal pollution is animal rather than human.

The last indicator organism to be discussed is yeast. Hagler and Mendonca-Hagler (1981) found that total yeast counts above 100 CFU/100 ml were typical of heavily and moderately polluted waters but atypical of lightly polluted and unpolluted areas. Total yeast counts were proportional to pollution levels. They found Candida krusei and phenotypically similar yeasts were prevalent in polluted estuarine water but rare in unpolluted seawater.

Environmental Variables

Heterotrophic bacteria numbers have been estimated in estuaries by Wood (1953,1959, 1965), Velankar (1955) and Oppenheimer (1960). Velankar, working in the Gulf of Manaar, India, recorded bacterial populations levels at the surface of the water and close to the bottom. He found that the viable count range from less than 100 to 850 colony forming units (CFU)/ml at the water surface, but was usually on the order of 200 to 300 CFU/ml. He also demonstrated that bacterial counts varied with the number of barnacles and other larvae on test panels in Sydney Harbour (Dew and Wood, 1955). In the water of Lake Macquarie, an irregular seasonal distribution of bacteria was found with a maximum viable count in June-July (Australian winter).

aeruginosa levels [illegible]

recreational [illegible]

in Lake [illegible] *[illegible]* may [illegible]

pollution of [illegible]

probability of [illegible]

coliform densities [illegible] *[illegible]* levels [illegible]

that the source of [illegible]

The last [illegible]

Mendonca-Hagler [illegible]

ml were typical of [illegible]

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Environmental Variables

Heterotrophic [illegible]

by Wood (19[illegible]) [illegible] Velankar (19[illegible]) and [illegible]

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of Lake Macquarie, [illegible]

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The surface counts were also slightly higher on the average than those from close to the bottom, but the numbers were of the same order as those reported by Velanker (1955). The range of counts (5 to 13,000/ml) was much greater than that found by Velankar, due no doubt to the nutrients washed into the lake by flash floods. Microbial populations of estuarine sediments have also been studied. Oppenheimer found that aerobic bacteria from the sediment surface in Texas Bay ranged from 5×10^5 to 5×10^6 and Wood recorded bacterial counts from 3×10^5 to 6.5×10^5 in Lake Macquarie.

The sediments of an estuary can serve as a reservoir for indicator bacteria. In the sediments of Lynnhaven Estuary, Virginia, the concentration of indicator bacteria was extremely high and even the indicator organisms may pose a potential health hazard. Disturbance of the uppermost sediment layer by commercial, natural and recreational activities, such as dredging, boating, tides or storms would resuspend the existing fecal organisms (Erkenbrecher, 1980). Goyal and co-workers (1977) found a similar situation in Texas. He found total coliforms, fecal coliforms and Salmonella in greater number in sediments than in overlying water. Heavy rainfall resulted in large increases in the number of organisms in both water and sediment samples. The bottom sediment in the shallow canal systems can act as reservoirs of enteric bacteria, which may be resuspended in response to various environmental factors and recreational activities. The problem of resuspension of sediment-bound fecal coliforms was also examined in the Mississippi River (Grimes, 1975). Fecal coliform concentrations increased significantly in the immediate vicinity of a dredging operation. Increased counts were attributed to the

The [illegible] were [illegible] than those [illegible] order [illegible]

[illegible]

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Saylor and co-workers (1975) enumerated total viable, heterotrophic bacteria, total coliform, fecal coliform and fecal streptococci in the Chesepeake Bay and found significant levels of pollution indicator organisms in all samples. The indicator organisms distribution was independent of temperature, salinity and the concentration of suspended sediments. Most total viable bacteria counts (53%) and fecal indicator counts (80%) were directly correlated with suspended sediments concentrations. Correlation coefficient (r) for the indicator organisms examined in this study were r= 0.80 for bottom water and r= 0.99 for suspended sediments. Prolonged survival of fecal streptococci in most sediment samples was observed. This is probably due to bottom sediments having a high absorptive capacity and the ability to regulate basic nutrient concentration and eutrophication in situ (Hendricks, 1971).

Runoff affects coliform counts in the estuary. Faust (1976) determined the rural watershed contributed to the fecal coliform pollution of the Rhode River and calculated that on the average 1% of fecal coliform produced by the animals was washed into the estuaries by land runoff. These results agree with those of Doran and Linn (1979) who compared grazed and ungrazed pastureland in eastern Nebraska. Total coliform, fecal coliform, fecal streptococci were monitored. Bacteriological counts in runoff from grazed areas contained five to ten times more fecal coliform than runoff from fenced, ungrazed areas. Total coliform levels were the same at the two sites, but fecal streptococci counts were higher in runoff from distribution of [illegible]

concentrations [illegible]

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network [illegible] total [illegible]

streptococci [illegible]

pollution [illegible]

distribution [illegible]

concentration of [illegible]

counts (TC) and [illegible] counts [illegible]

with [illegible] disease [illegible] for [illegible]

for the indicator [illegible] examined [illegible]

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of fecal streptococci [illegible] samples [illegible] This is

probably due [illegible] both [illegible] ability

the ability to regulate basic nutrient [illegible] and

eutrophication [illegible] (Hendricks, 1971).

[illegible] fecal coliform counts [illegible] (1976)

determined the [illegible] watershed contributed [illegible]

pollution of the [illegible] River and [illegible]

fecal coliform produced by the animals [illegible]

by land runoff [illegible] results [illegible]

(1973) who [illegible] grazed and [illegible]

Nebraska. Total coliform, fecal coliform [illegible] were

monitored. Bacteriological counts [illegible]

contained five to ten times more [illegible] from

fenced, ungrazed areas. Fecal [illegible] at the

two sites, but fecal streptococci [illegible] runoff from ungrazed areas and reflected the contribution from wildlife. The fecal coliform / fecal streptococci ratio in pasture runoff was used in in this study to identify the relative contribution of cattle and wildlife. Ratios below 0.06 were indicative of wildlife sources and ratios above 0.1 were characteristic of grazing cattle.

Karthegisan and Thomas (1976) found the number of fecal coliform, total coliform and E. coli type 1 to be related to the salinity conditions of the tidal water covering the sites. These results are similar to those of the Lynnhaven Estuary, Virginia where indicator bacteria varied substantially throughout the estuary, but the higher salinity water and coarser sediments of the inlet showed lower overall bacterial counts than the headwater sites where freshwater runoff decreased tidal effect (Erkenbrecher, 1980). This reduction in bacterial count could be due to debilitation and dilution (Dawe and Penrose, 1978). When the bacteria enter salt water, they become stressed, will not grow on selective media, and were not competitive with other bacteria.

Sewage treatment plants, septic systems and boating activity influences the number of bacteria in the estuary. Sewage disposal and septic tank seepage in estuarine systems provided a major method of pathogenic introduction to estuarine ecosystems. Infectious viruses were especially hazardous because they can be recovered in estuarine waters 46 weeks after dumping. Increasing frequency of antibiotic resistant bacteria, found in the Chesapeake Bay and New York Bight, is also cause for alarm (Colwell and Kaper, 1977). Septic system failures were also found to pose a serious health hazard in the Lynnhaven Estuary, Virginia (Erkenbracher, 1980).

To estimate the potential hazards of sewage disposal, modeling experiments have been performed (Kuo and Jacobson, 1976). They predicted the distribution of sewage constituents that would result from a proposed sewage outfall in estuaries or coastal seas. Application of the technique required dye dispersion experiments and a numerical model employing the results of the experiments. The method was used to assess the environmental impact of a proposed sewage outfall in Hampton Roads, Virginia. Data from dispersion experiments were used to predict the concentration patterns of total nitrogen, total phosphorus, coliform bacteria, BOD, dissolved oxygen deficit and chlorine residuals that would result from the proposed sewage outfall.

Bane and Walker (1980) conducted a study of coliform related marine pollution in Brunswick County, North Carolina, where it was discovered that the total and fecal coliform populations vary at a rate directly proportional to the change in boating activity. The only measured environmental stimulus that affected the total and fecal coliform count was rainfall.

Coliphages are indicators of enteric viruses in shellfish and estuarine waters containing shellfish (Vaughn and Metcalf, 1975). Synoptic examinations of sewage effluents, shellfish and shellfish growing waters for coliphage and enteric viruses indicate a wide dissemination of coliphage throughout Great Bay Estuary, NH, but no resulting public health problem occured. The serious shortcomings of the coliphage indicator system for enteric virus detection are the potential for the presence of more than one dominant coliphage type and the inability to relate coliphage and pathogenic enteric virus occurrence in field samples.

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A [illegible] machine [illegible] from [illegible] rate directly proportional to the [illegible] only [illegible] source [illegible] solution were described.

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The pollution of oysters was examined in Hong Kong (Morton, 1975) where oysters are cultured by the primitive method of bottom-laying in polluted water. The oysters are fecally contaminated, particularily in the summer when monsoons flush out contaminants from rivers and streams into oyster producing areas. The contamination level is high and comprises effluents derived largely from the neighboring agricultural areas of Hong Kong and southern China.

The North Carolina Shellfish Sanitation Program, Department of Health Services runs annual surveys of the oyster beds and waters of Stones Bay (New River Estuary, Jacksonville, N.C.) to monitor the coliform levels in the oysters. As a result, portions of the bay are closed to shellfishing.

Economic Significance

A final important consideration of estuarine pollution is the economic loss of our estuarine resource. One major drawback is attempting to put a dollar value to the damage observed. The economic losses can range from a few thousand dollars to several million dollars per incident of estuarine damage ie., shellfish restrictions, duck death due to oil spills, shoaling of a major harbor due to improper hydraulic modification, loss of coastal marsh, loss of swimming recreation due to high coliform counts and lack of potable water (Wasserman, 1970).

The National Science Foundation-funded SOS project at UNC-W (Bane, manuscript) evaluated the socio-economic loss by bacterial pollution to fishermen in Brunswick County. The loss was determined to be $421,117.00, affecting 40 full time jobs per year; this represents a negligible loss when compared to total Brunswick County seafood resources, but a large loss to the individual fisherman.

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The [illegible] Shellfish Sanitat[illegible]

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Sto[illegible] estuary, Jacksonville, [illegible]

[illegible] a result, [illegible]

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Economic [illegible]

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dollars [illegible] locations,

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METHODS AND MATERIALS

A total of 366 bacteriological samples from 65 sampling sites was collected between November 30, 1980 and December 7, 1981. The sampling dates are listed on Table 2. The sampling area was the region of the New River Estuary between Stones Bay and the river north of Jacksonville (Figure 1). Sample sites, indicated on the map in Appendix I, were selected for their proximity to either permanent channel markers or automobile bridges. Seven sites designated major stations (Figure 2) were sampled at least once per month and the remaining 58 stations were sampled at least three times and are designated by station number identifier codes. The location of these stations are given in Appendix I. Samples at major stations also had identified codes (see Figure 2 for explanation).

FIELD COLLECTION

Thirteen student workers assisted in field and laboratory analysis of which eight were funded and five received credit in Seminar in Environmental Studies, EVS 495. The students worked under the direct supervision of the Project Director and performed routine tasks in order to allow for increased numbers of samples to be analyzed.

Water for analysis was collected in presterilized 200 ml glass bottles. The bottles were submerged a few inches below the water surface by a gloved hand with the bottle mouth facing upstream. The bottles were filled with 25 mls of air left in the top. The samples

FIGURE 1 - NEW RIVER ESTUARY SAMPLE AREA AND RAIN GAUGE LOCATIONS

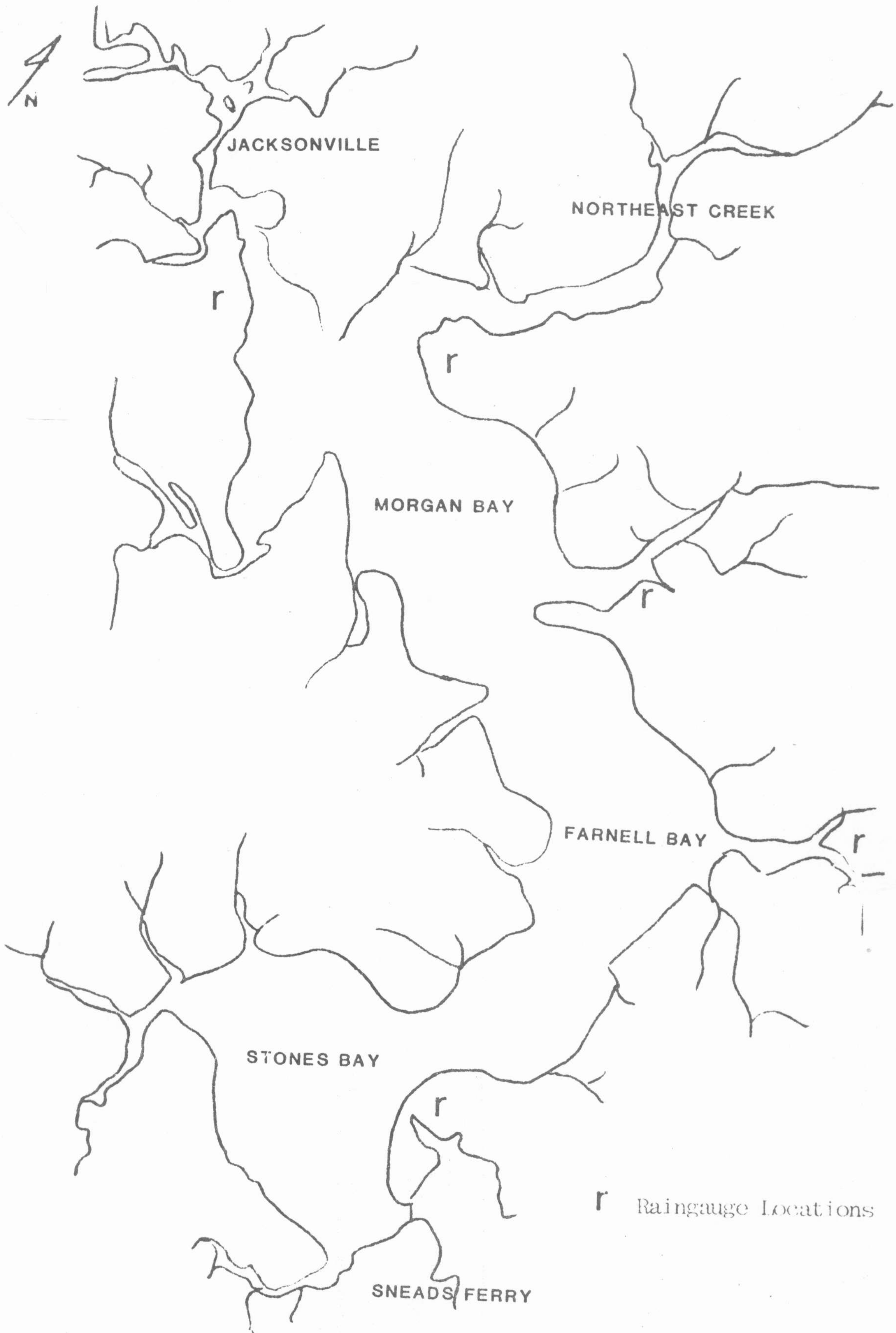

N
JACKSONVILLE
NORTHEAST CREEK
MORGAN BAY
FARNELL BAY
STONES BAY
SNEADS FERRY
r Raingauge Locations

FIGURE 2 - SEVEN MAJOR SAMPLING STATIONS IN THE NEW RIVER ESTUARY

STATION 1 IS STATION NUMBER IDENTIFER CODES 22 - 37

STATION 2 IS STATION NUMBER IDENTIFER CODES 81 - 95

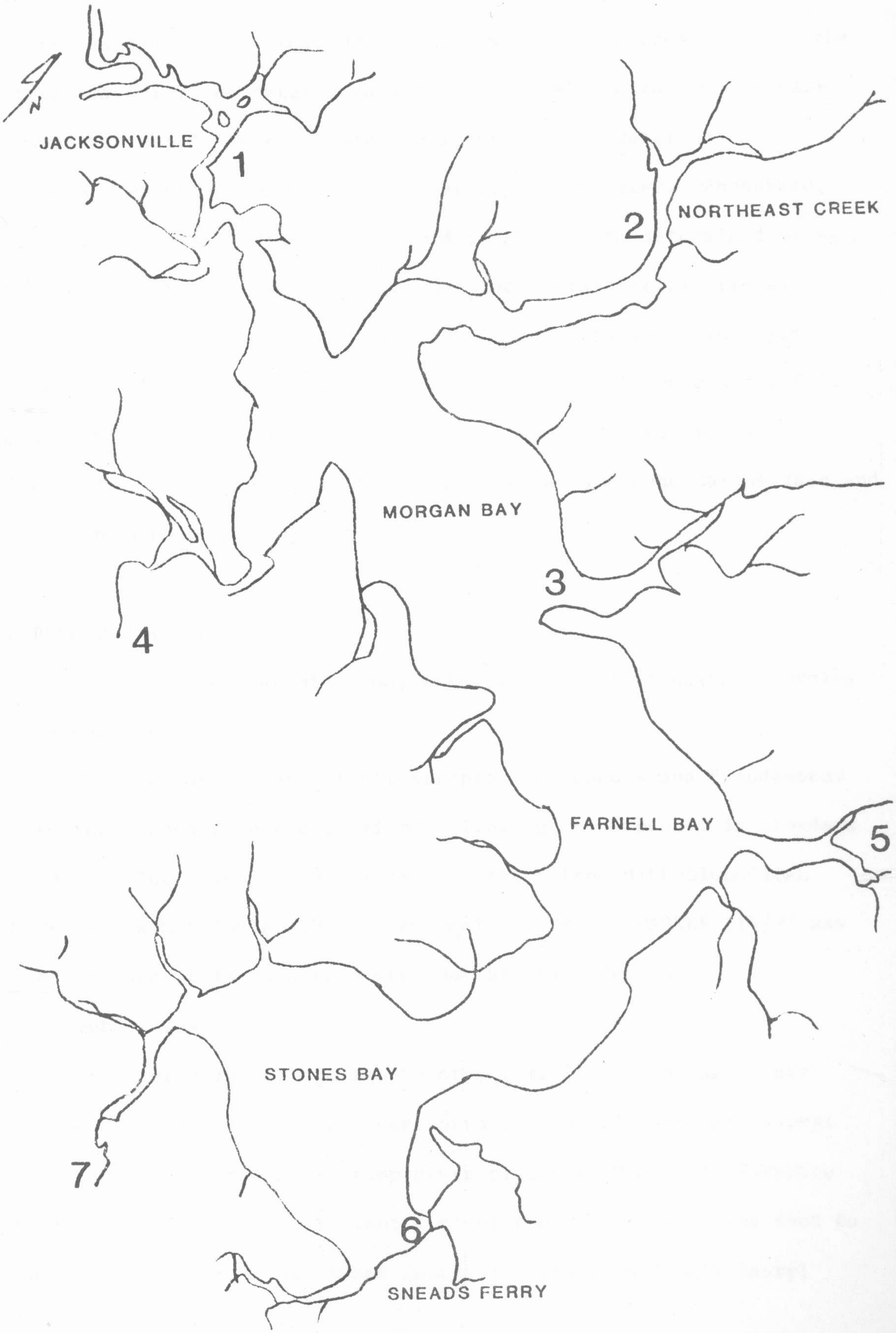
STATION 3 IS STATION NUMBER IDENTIFER CODES 160 - 177

STATION 4 IS STATION NUMBER IDENTIFER CODES 133 - 142

STATION 5 IS STATION NUMBER IDENTIFER CODES 254 - 264

STATION 6 IS STATION NUMBER IDENTIFER CODES 356 - 366

STATION 7 IS STATION NUMBER IDENTIFER CODES 347 - 355


N
JACKSONVILLE
1
NORTHEAST CREEK
2
MORGAN BAY
3
4
FARNELL BAY
5
STONES BAY
7
6
SNEADS FERRY

were stored on ice during transit to the laboratory. No more than six hours elapsed from collection time to laboratory processing. In the field, salinity was determined with a hand-held refractometer (All commercial suppliers are listed in Appendix II); water and air temperatures were recorded with a mercury thermometer. Phosphate, nitrate, dissolved oxygen and turbidity tests were determined using the Hach DR-EL/4 according to the manufacturers specifications. Dissolved oxygen was also determined with a portable field oxygen meter. Rainfall measurements were obtained from Tru-check rainfall gauges (locations on Figure 1); and additional information was obtained from the Environmental Center at Camp Lejeune Marine Base and the Camp Lejeune Air Station.

LABORATORY ANALYSIS

To avoid ion contamination, water was distilled using a Corning Mega-pure still.

The coliform counts, fecal streptococci counts and Pseudomonas aeruginosa counts were determined following the protocol in Standard Methods. The only change was the MPN table from MICROBIOLOGICAL METHODS FOR MONITORING THE ENVIRONMENT: WATER AND WASTES (1978) was used because it is more complete than Standard Methods.

Presumptive Test

Upon returning to the laboratory, 1 ml from each sample was placed into each of 5 test tubes containing single-strength lauryl tryptose. Another 1 ml of sample was placed in 9 mls of phosphate buffer, to make a 0.1 dilution; 1 ml of the 0.1 dilution was used to inoculate each of 5 test tubes containing single-strength lauryl

tryptose. One ml of the 0.1 dilution was placed in another 9 mls of phosphate buffer, making a 0.01 dilution; 1 ml of the 0.01 dilution was used to inoculate each of 5 test tubes of single-strength lauryl tryptose.

An inverted Durham tube was placed in each test tube to concentrate gases and to indicate positive or negative results. A positive presumptive test shows gas formation after incubation of 24 hours or 48 hours at 35° C.

Confirmed and Fecal Coliform Tests

Each positive presumptive test was used to inoculate an EC Medium and a 2% Brilliant Green Bile Broth (BGB), performed with a sterile wooden swab submerged once around the lauryl tryptose tube, once around the EC tube and finally once around the BGB. The EC Medium was incubated in a water bath at 44.5°C for 24 hours. A positive reaction for fecal coliform is indicated by gas formation in the inverted Durham tube after incubation.

The BGB tubes are incubated at 35° C for 24 hours or 48 hours. The formation of gas in an inverted Durham tube indicates a positive test for coliform bacteria.

Completed Test

The positive confirmed tubes are inoculated onto Eosin Methylene Blue (EMB) agar plates; EMB is a medium that cultures only gram negative rods. The plates are incubated at 35° C for 24 hours and were used to tentively identify specific organisms: Escherichia coli has a dark metallic green sheen; Enterobacter aerogens produces a colony with a dark nucleus but no metallic green sheen; Klebsiella sp., large pink mucoid colony; and Proteus sp., spreading pink colony tryptose. One ml [illegible] 0.1 [illegible] plate [illegible] 9 ml of phosphate buffer [illegible] was used to [illegible] tryptose.

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Confirmed and [illegible]

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The [illegible] tubes [illegible] The formation of [illegible] test for coliform [illegible]

Completed Test

The positive [illegible] tubes are [illegible] blue (EMB) agar plates [illegible] negative rods. [illegible] are incubated at [illegible] and were used [illegible] specific [illegible] has a dark metallic [illegible] sheen; *Enterobacter* [illegible] colony with a dark [illegible] sp., large pink [illegible] and *Proteus* [illegible] with a foul odor. A positive EMB test indicates *E. coli*.

FECAL STREPTOCOCCI

Presumptive Test

One ml of sample was placed into each of 5 test tubes containing 10 mls of single-strength azide dextrose broth. Another 1 ml of sample was placed in 9 ml of phosphate buffer to make a 0.1 dilution; 1 ml of the 0.1 dilution was used to inoculate each of 5 test tubes. One ml of the 0.1 dilution was placed in another 9 ml of buffer, making a 0.01 dilution; 1 ml of the 0.01 dilution was used to inoculate each of 5 test tubes of azide dextrose broth.

The inoculated test tubes are incubated at 35° C for 24 hours or 48 hours. A positive presumptive test shows turbidity after incubation.

Confirmed Test

Each positive azide dextrose broth was transfered to a tube of ethyl violet azide broth. The transfer was performed with a sterile wooden swab from the azide dextrose to the ethyl violet azide broth.

The inoculated tubes are incubated for 48 hours at 35° C. A positive confirmed test was indicated by the formation of a purple button at the bottom of the tube or occasionally by a dense turbidity.

PSEUDOMONAS AERUGINOSA

Presumptive Test

One ml of sample was placed in each of 5 test tubes containing 10 mls of asparagine broth. Another 1 ml of sample was placed in 9 ml of phosphate buffer, to make a 0.1 dilution; 1 ml of the 0.1 dilution was with a foul odor. A positive IMVC test indicates E. coli.

FECAL STREPTOCOCCI

Presumptive Test

One ml of sample was placed into each of 5 test tubes containing 10 mls of single-strength azide dextrose broth. Another 1 ml of sample was placed in 9 ml of phosphate buffer to make a 0.1 dilution; 1 ml of the 0.1 dilution was used to inoculate each of 5 test tubes. One ml of the 0.1 dilution was placed in another 9 ml of buffer, making a 0.01 dilution; 1 ml of the 0.01 dilution was used to inoculate each of 5 test tubes of azide dextrose broth.

The inoculated test tubes are incubated at 35° C for 24 hours or 48 hours. A positive presumptive test shows turbidity after incubation.

Confirmed Test

Each positive azide dextrose broth was transferred to a tube of ethyl violet azide broth. The transfer was performed with a sterile wooden swab from the azide dextrose to the ethyl violet azide broth.

The inoculated tubes are incubated for 48 hours at 35° C. A positive confirmed test was indicated by the formation of a purple button at the bottom of the tube or occasionally by a dense turbidity.

PSEUDOMONAS AERUGINOSA

Presumptive Test

One ml of sample was placed in each of 5 test tubes containing 10 mls of asparagine broth. Another 1 ml of sample was placed in 9 ml of phosphate buffer, to make a 0.1 dilution; 1 ml of the 0.1 dilution was used to inoculate each of 5 test tubes of asparagine broth. One ml of the 0.1 dilution was placed in another 9 mls of buffer, making a 0.01 dilution; 1 ml of the 0.01 dilution was used to inoculate each of 5 test tubes of asparagine broth.

The inoculated test tubes were incubated at 35 °C for 24 hours or 48 hours. The medium in a positive presumptive test tube will fluoresce when exposed to long wave ultra-violet light.

Confirmed Test

One drop of asparagine broth was removed from a positive presumptive tube and placed on an acetamide agar slant. The tubes were incubated at 35 to 37°C for 24 to 36 hours. A positive confirmed test was indicated by the development of an alkaline pH in the medium as indicated by a purple color.

SURVEY

A survey was taken to determine the use of the New River by boaters and fishermen, both commercial and recreational. A list of the addresses of owners with boat permits was obtained from North Carolina Division of Marine Fisheries. A random selection of 200 owners were sent questionnaires (Appendix III) and another 62 questionnaires were sent to local fishing clubs.

used to inoculate each of [illegible] One ml of the 0.1 dilution was added [illegible] dilutions [illegible] test tubes of [illegible]

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Confirmed test

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SURVEY

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RESULTS

The MPN's of each of the seven major stations that were sampled from November 1980 to December 1981 are shown individually in Figures 2-9. The data from the remaining 58 minor stations are shown in Appendix I. The fecal coliform counts (EC counts) ranged from 0 (Figures 3,4,5,7,8) to 16000 (Figure 4) (mean = 1200). The total coliform counts (EMB counts) range from 0 (Figures 3,4,5,7,8,9) in the winter to 24000 (Figure 3) in the spring (mean = 400). Both EC and EMB counts are high in the streams and decrease in the bay.

The range, mean, standard deviation and standard error for each station are shown in Figure 10 (EC counts) and Figure 11 (EMB counts). The EC counts are highest in the northeast quadrant of the New River Estuary, especially in the river at Jacksonville (mean = 1300) and in Northeast Creek (mean = 949). The lowest values occur in Stones and Farnell Bays which had high tidal fluctuation, deep water and lower human population on adjoining land areas. The lowest EMB counts occur in the middle water of the estuary (range 21 to 231). Highest EMB counts were along the northeast shore, especially at Wallace Creek (mean = 1780). Other high counts occur in Frenchs and Northeast Creeks. EMB counts on the western shore ranged from 0 to 24000 (mean =1200). South and western shores had moderate counts (mean = 550).

Most of the study area was rural and unpopulated. The exceptions were Jacksonville (Station 1), Northeast Creek (Station 2), Camp Lejeune Marine Base (eastern shore) and Dixon (Station 7). These areas were thought to contribute to the bacterial concentration in the New River area.

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9. The data fro[illegible]

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,4,5,7,8) to [illegible]

HB counts range [illegible]

Figure 3) in th[illegible]

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FIGURE 3 - BACTERIOLOGICAL ANALYSIS OF STATION 1 FROM NOVEMBER 1980 - DECEMBER 1981 - NEW RIVER ESTUARY

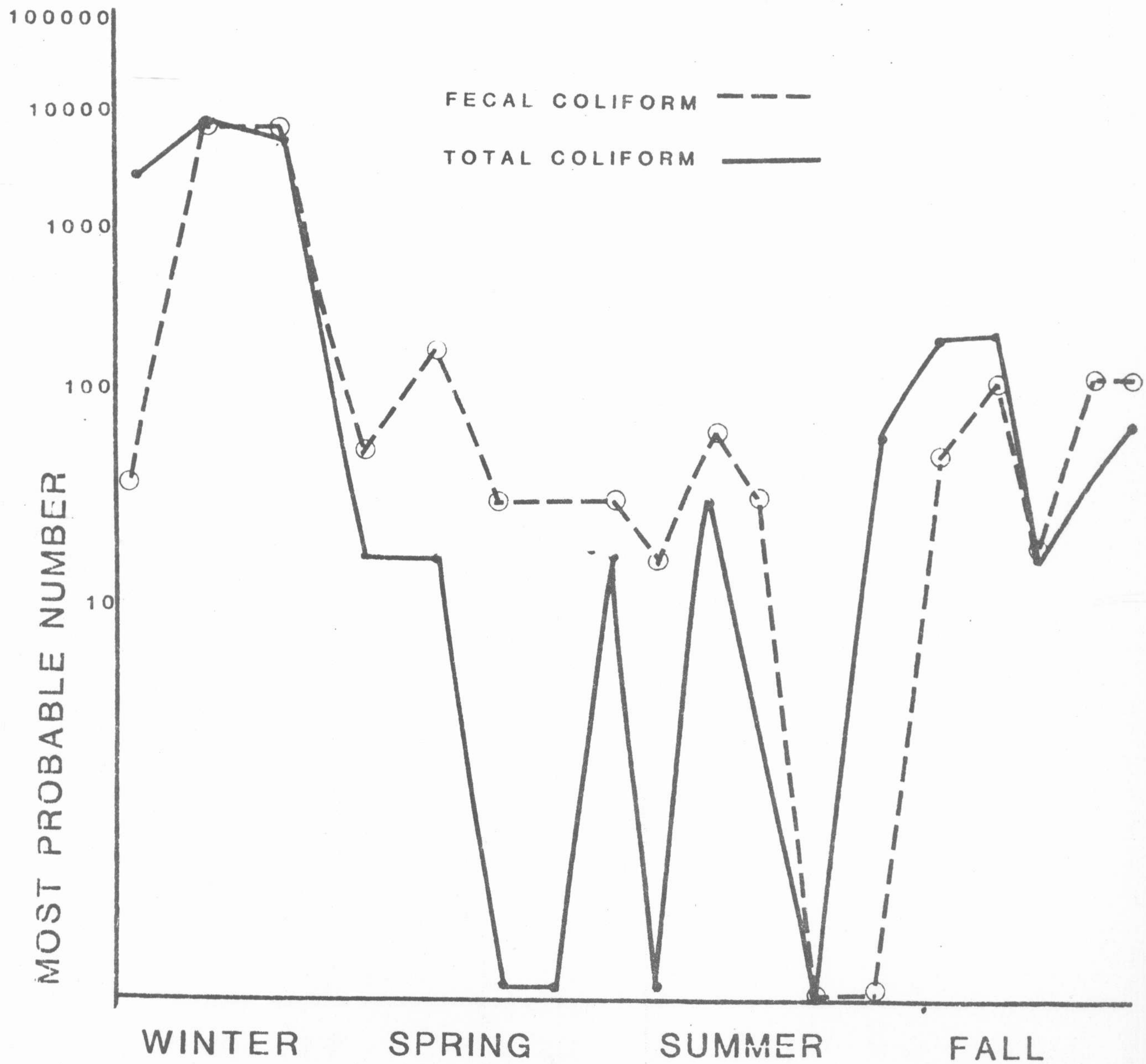
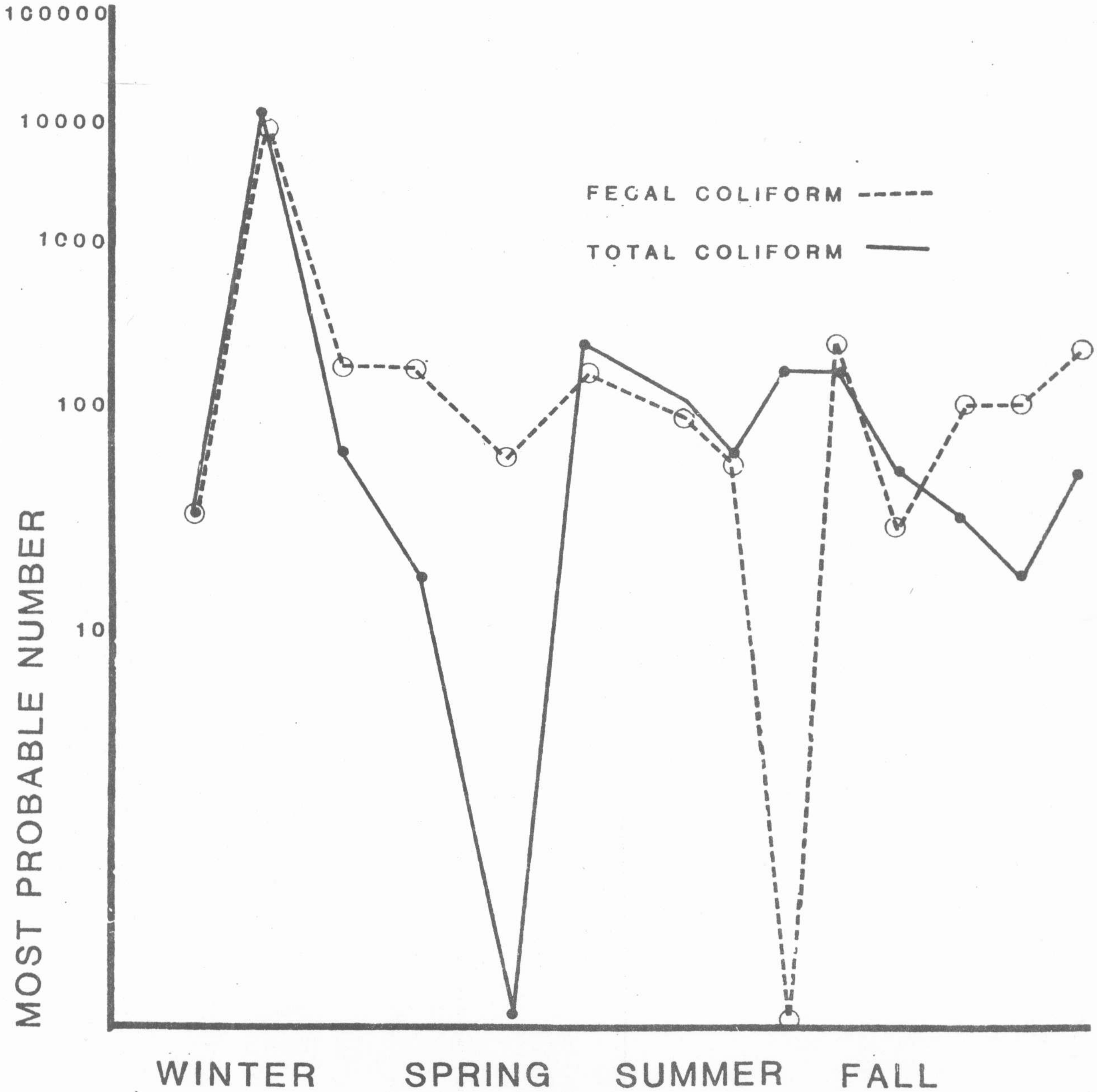

100000
10000
1000
100
10
MOST PROBABLE NUMBER
FECAL COLIFORM
TOTAL COLIFORM
WINTER
SPRING
SUMMER
FALL

FIGURE 4 - BACTERIOLOGICAL ANALYSIS OF STATION 2 FROM NOVEMBER 1980 - DECEMBER 1981 - NEW RIVER ESTUARY


100000
10000
1000
100
10
MOST PROBABLE NUMBER
FECAL COLIFORM
TOTAL COLIFORM
WINTER
SPRING
SUMMER
FALL

MOST PROBABLE NUMBER
100
WINTER
SUMMER
FALL

FIGURE 5 - BACTERIOLOGICAL ANALYSIS OF STATION 3 FROM NOVEMBER 1980 - DECEMBER 1981 - NEW RIVER ESTUARY

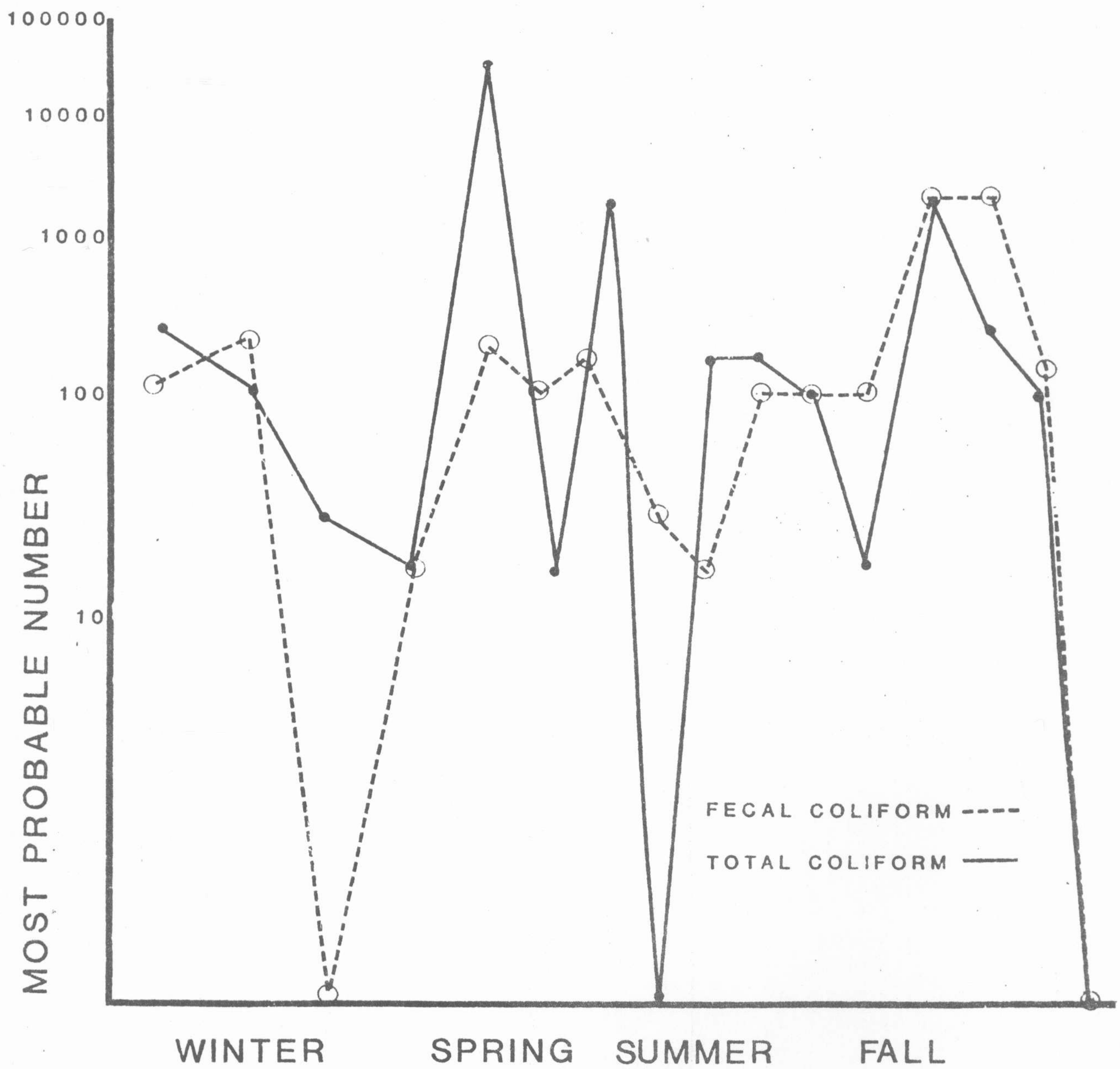
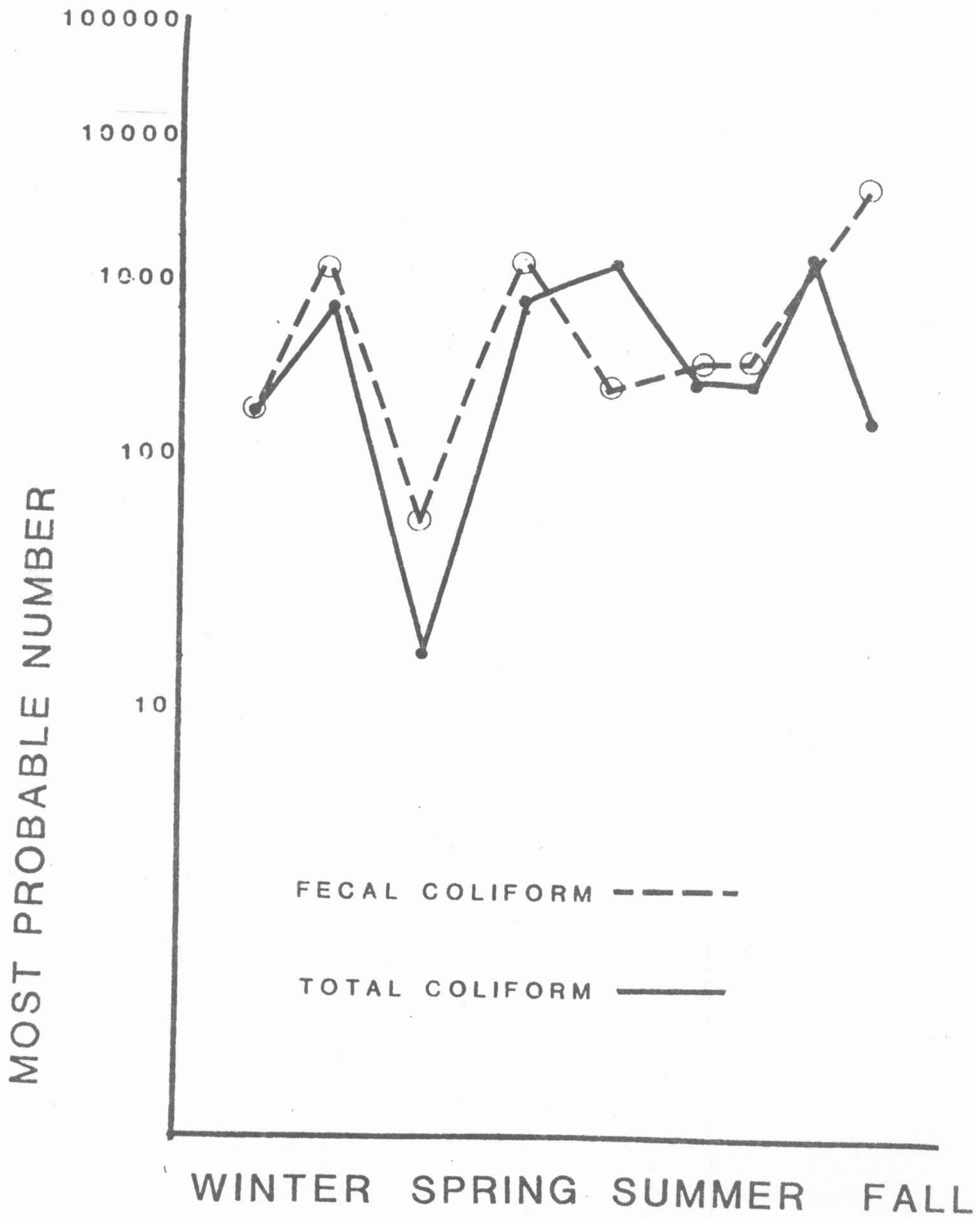

100000
10000
1000
100
10
MOST PROBABLE NUMBER
FECAL COLIFORM ----
TOTAL COLIFORM ——
WINTER
SPRING
SUMMER
FALL

FIGURE 6 - BACTERIOLOGICAL ANALYSIS OF STATION 4 FROM NOVEMBER 1980 - DECEMBER 1981 - NEW RIVER ESTUARY


100000
10000
1000
100
10
MOST PROBABLE NUMBER
FECAL COLIFORM
TOTAL COLIFORM
WINTER SPRING SUMMER FALL

MOST PROBABLE NUMBER
WINTER
SPRING
SUMMER
FALL

FIGURE 7 - BACTERIOLOGICAL ANALYSIS OF STATION 5 FROM NOVEMBER 1980 - DECEMBER 1981 - NEW RIVER ESTUARY

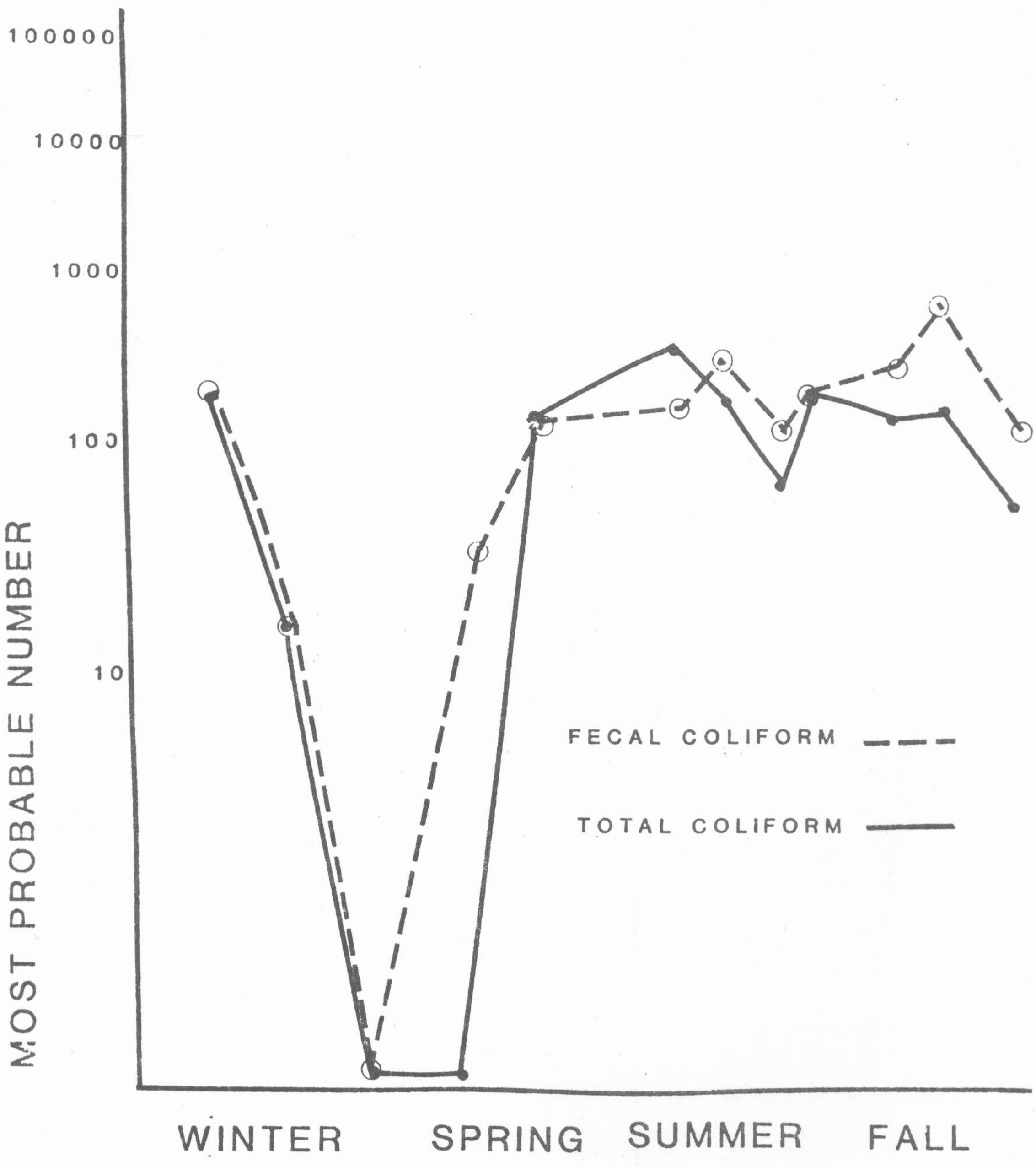

100000
10000
1000
100
10
MOST PROBABLE NUMBER
FECAL COLIFORM
TOTAL COLIFORM
WINTER
SPRING
SUMMER
FALL

FIGURE 8 - BACTERIOLOGICAL ANALYSIS OF STATION 6 FROM NOVEMBER 1980 - DECEMBER 1981 - NEW RIVER ESTUARY

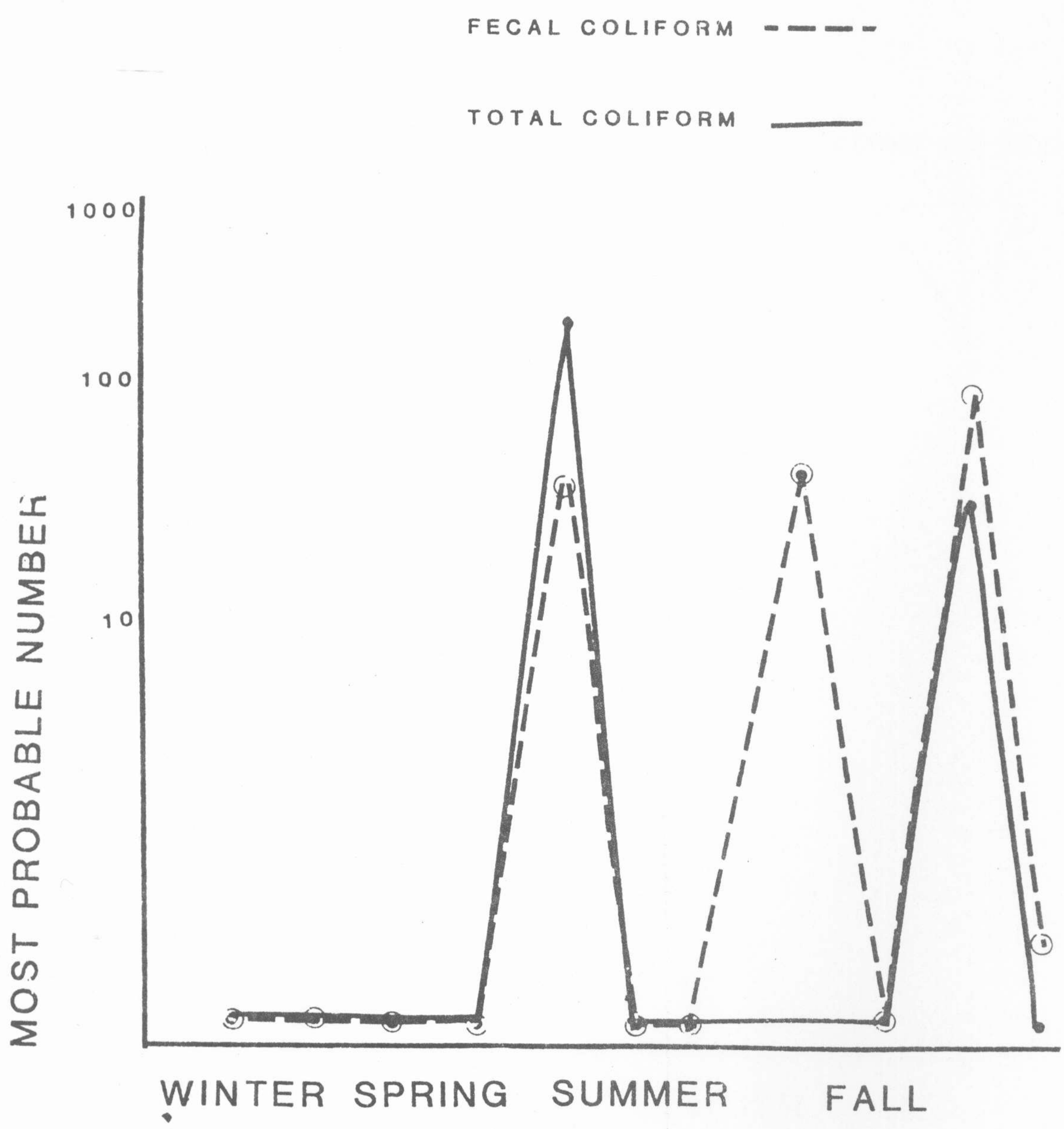
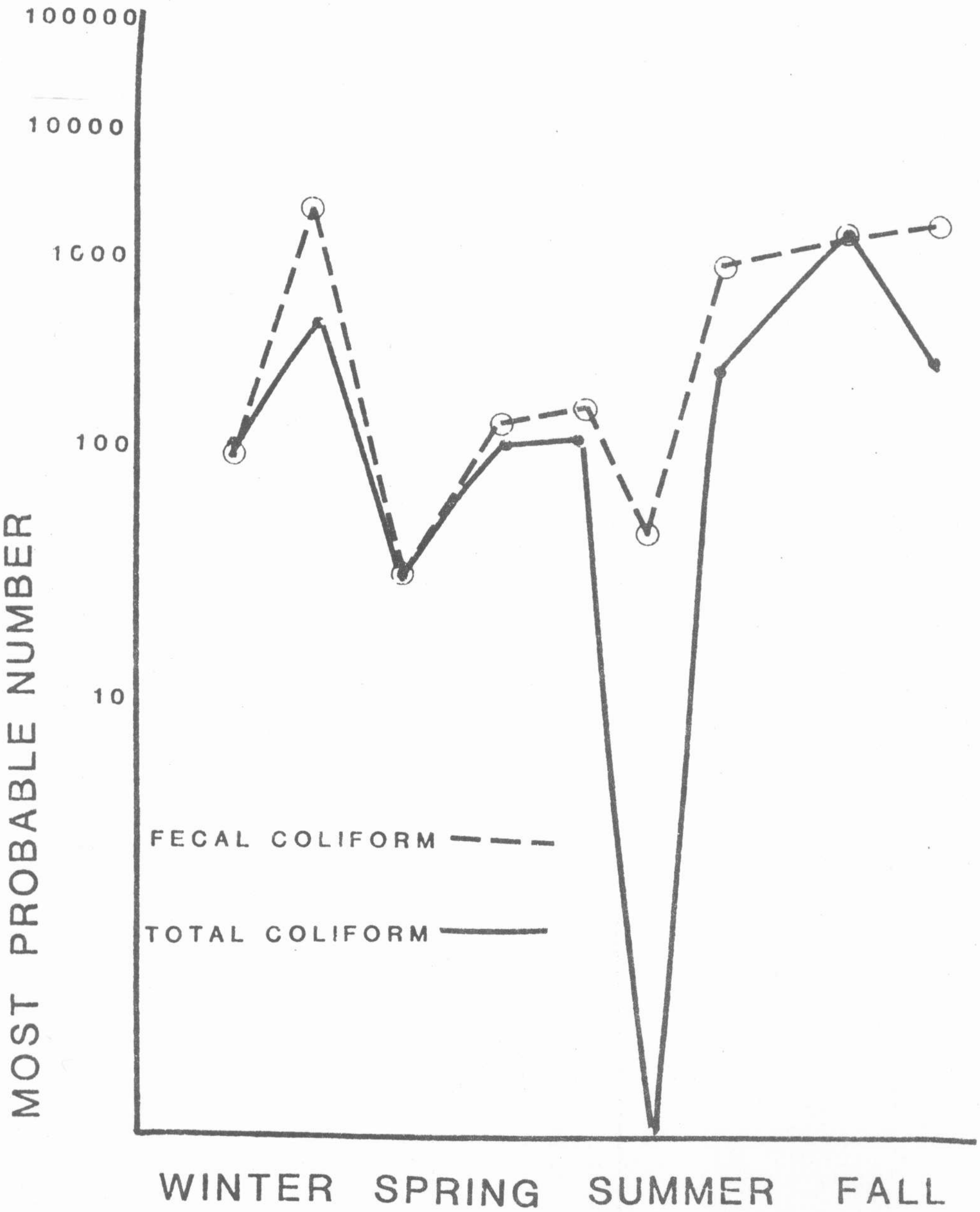
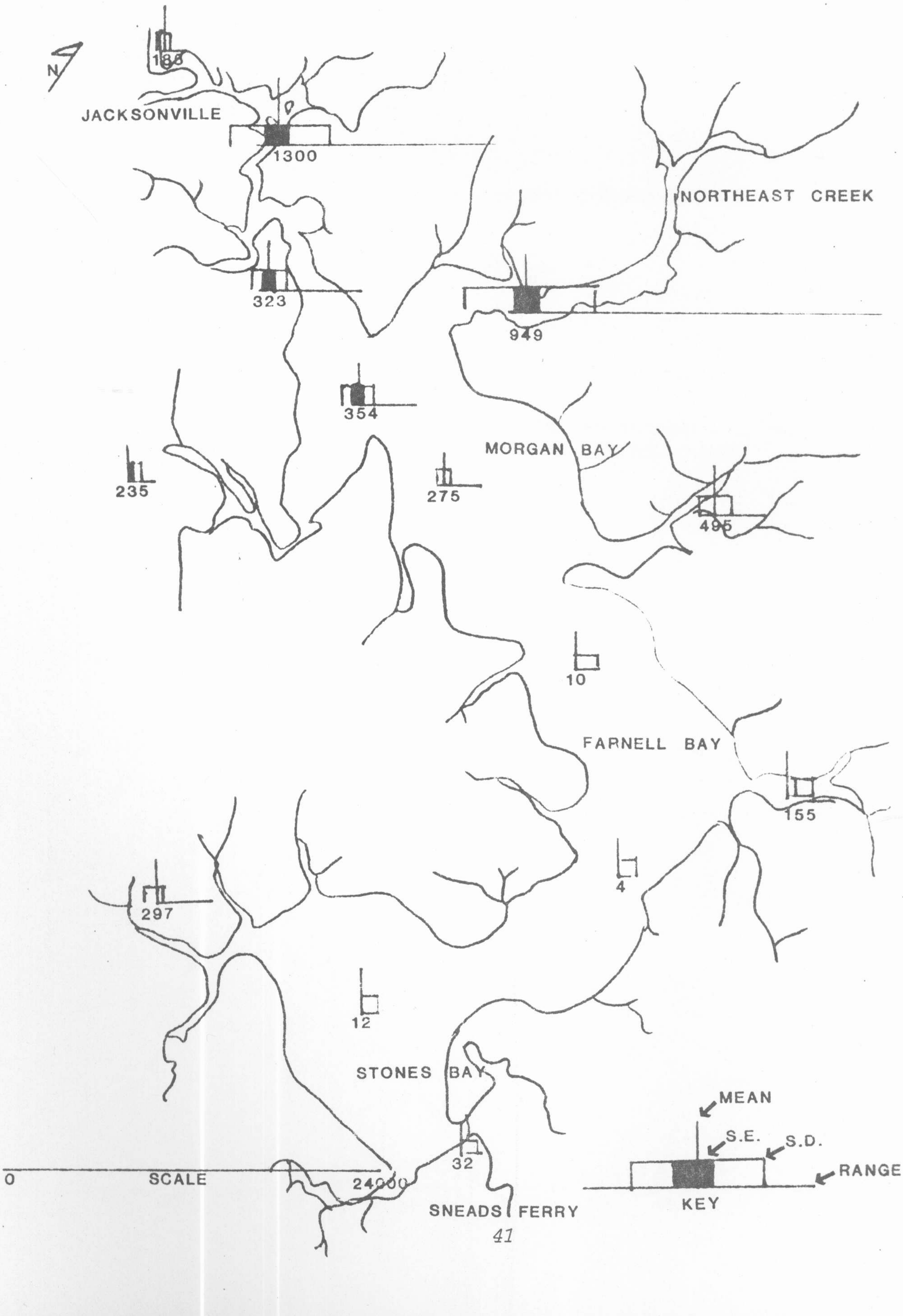

FECAL COLIFORM
TOTAL COLIFORM
1000
100
10
MOST PROBABLE NUMBER
WINTER SPRING SUMMER FALL

FIGURE 9 - BACTERIOLOGICAL ANALYSIS OF STATION 7 FROM NOVEMBER 1980 - DECEMBER 1981 - NEW RIVER ESTUARY



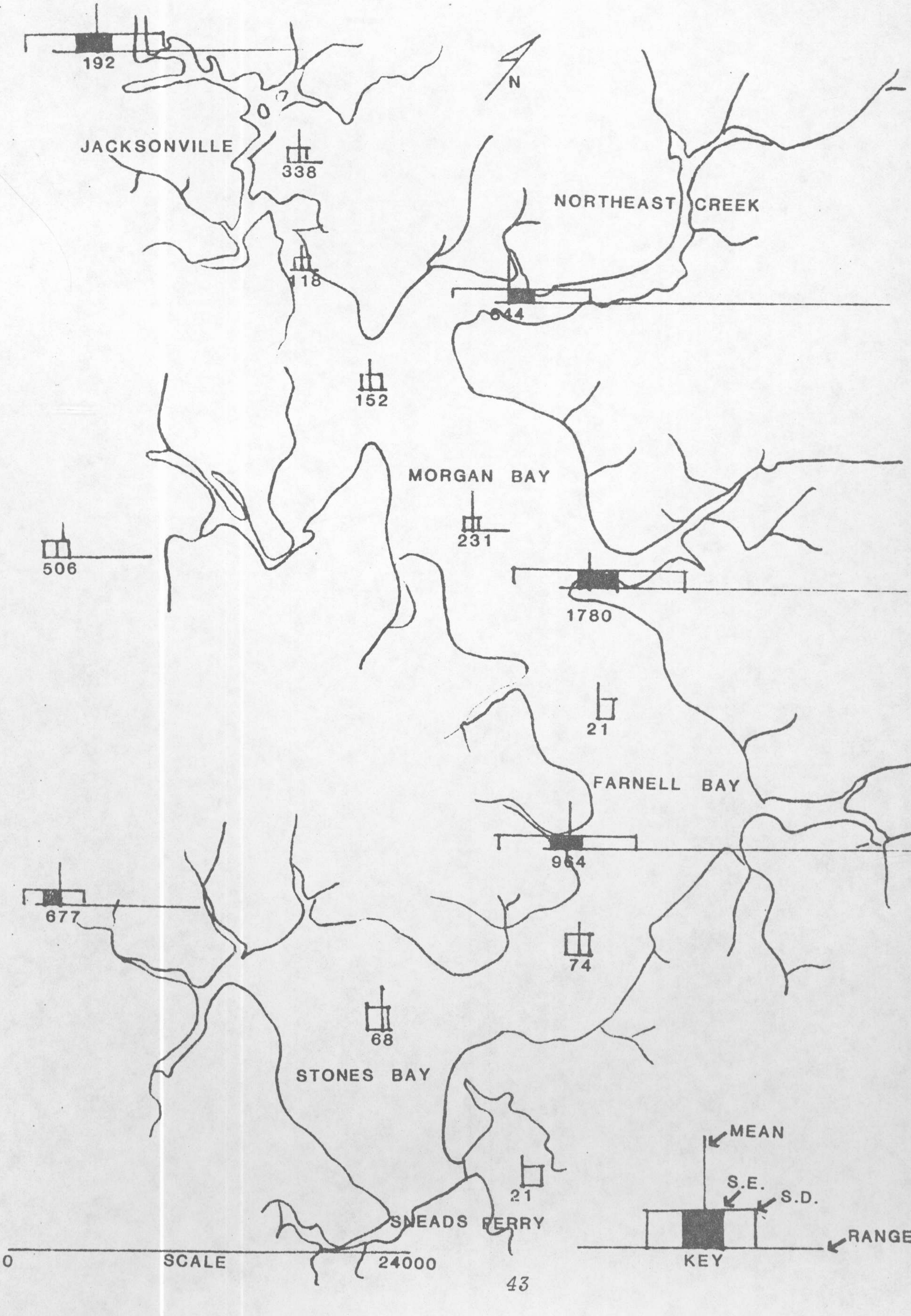
100000
10000
1000
100
10
MOST PROBABLE NUMBER
FECAL COLIFORM
TOTAL COLIFORM
WINTER
SPRING
SUMMER
FALL

FIGURE 10 HUBBS-HUBBS DIAGRAMS OF FECAL COLIFORM (EC) COUNTS IN NEW RIVER ESTUARY FROM NOVEMBER 1980 - DECEMBER 1981



N
188
JACKSONVILLE
1300
NORTHEAST CREEK
323
949
354
MORGAN BAY
235
275
495
10
FARNELL BAY
155
4
297
12
STONES BAY
MEAN
S.E.
S.D.
RANGE
KEY
0
SCALE
24000
32
SNEADS FERRY

FIGURE 11 - HUBBS-HUBBS DIAGRAMS OF TOTAL COLIFORM (EMB) COUNTS IN NEW RIVER ESTUARY FROM NOVEMBER 1980 - DECEMBER 1981


192
JACKSONVILLE
338
N
NORTHEAST CREEK
118
644
152
MORGAN BAY
231
506
1780
21
FARNELL BAY
964
677
74
68
STONES BAY
MEAN
S.E.
S.D.
21
SNEADS FERRY
RANGE
0
SCALE
24000
KEY

Salinity, turbidity and water temperature in the New River showed no distinguishable pattern. Figure 12 is the data from Station 5 and the remaining graphs are in Appendix III. No correlation was found between salinity and either the average total coliform (r=-0.34, 15df) or average fecal coliform (r=-0.44, 10df). No correlation was noted between turbidity and fecal coliform (r=-0.16, 6df) or turbidity and total coliform (r=0.19, 6df). Rainfall, on the other hand, was highly correlated with total coliform (r=0.65, 10df) and with fecal coliform (r=0.61, 10df).

Table 4 shows the number and ratio and expected source for fecal coliform counts and fecal streptococci counts. There was a strong correlation (r= 0.89, 15df) between the fecal coliform counts and fecal streptococci counts originating from suspected animal sources. Table 5 shows the number, ratio and expected source for fecal coliform counts and Pseudomonas aeruginosa counts. A correlation (r= 0.72, 49df) was found between the P. aeruginosa counts and fecal coliform counts originating from suspected human sources.

Rainfall (Table 6) was highest in August (9.65 inches), followed by June and May with 7.85 and 7.14 inches, respectively.

The results of the area use survey are compiled in Table 7. Most responses to question 1 consisted of two or more answers. Recreational fishing and shellfishing has the most participants; recreational boating is the second most popular activity. About 52% of the respondents use the river an average of 5.5 times per month and 30% use it once a month. The average respondent has fished 15.6 years in the area (range 3-35 years) and plans to fish for 20.5 more years.

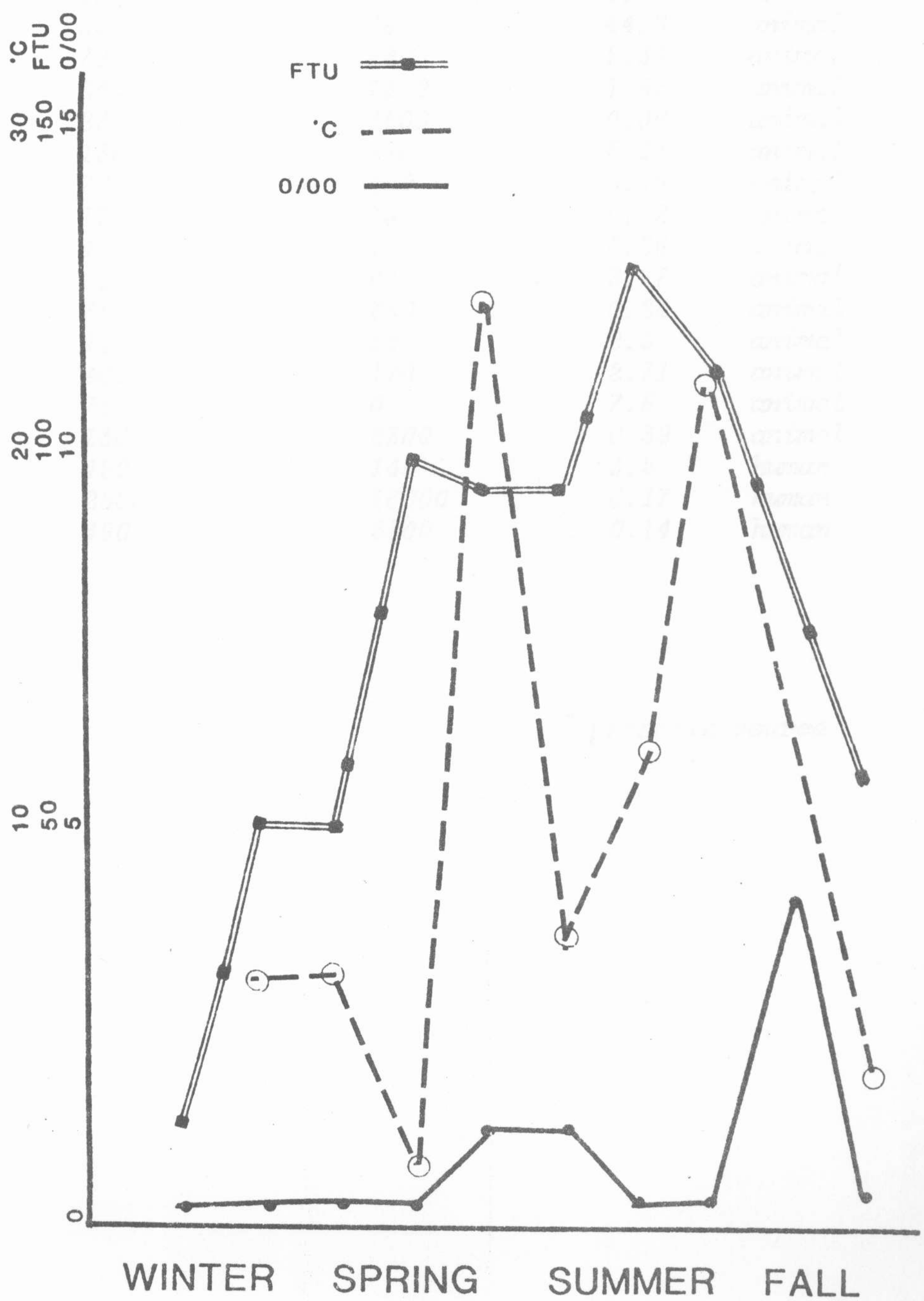
Salinity, turbidity and water temperature in the [illegible] River showed no distinguishable pattern. Figure 12 is [illegible] for Station 2 and the remaining graphs are in Appendix [illegible]. No correlation was found between salinity and either the average total coliform ([illegible], 10df) or average fecal coliform (r=-0.48, 10df) [illegible] correlation [illegible] between turbidity and [illegible] fecal coliform [illegible] total coliform (r=0.1[illegible], 10df). Rainfall [illegible] significantly correlated with total coliform (r=0.[illegible], 10df) and with fecal coliform (r=0.[illegible], 10df).

Table 4 shows the monthly [illegible] for total coliform counts and fecal streptococcal counts. There was a strong correlation (r=0.[illegible], [illegible]df) between the fecal coliform counts and fecal streptococcal counts obtained from suspected animal sources. Table 5 shows the monthly ratio and expected [illegible] of total coliform counts and *Pseudomonas aeruginosa* counts. A correlation (r=0.72, 49df) was found between the *P. aeruginosa* counts and total coliform counts originating from suspected human sources.

Rainfall (Table 6) was highest in August ([illegible] inches), followed by June and May with [illegible].05 and 4.14 inches, respectively.

The results of the area use survey are compiled in Table 7. Most responses to question 1 consisted of two or three uses. Recreational fishing and shellfishing was [illegible] by most participants; recreational boating is the second most popular activity. About 52% of the respondents use the river an average of [illegible] times per month and 30% use it once a month. The average respondent has fished 15.6 years in the area (range 3-35 years) and plans to fish for [illegible] more years.

FIGURE 12 - SALINITY, TURBIDITY AND WATER TEMPERATURE AT STATION 5 FROM NOVEMBER 1980 - 1981 NEW RIVER ESTUARY



°C
FTU
0/00
30
150
15
20
100
10
10
50
5
0
FTU
°C
0/00
WINTER
SPRING
SUMMER
FALL

TABLE 4 - FECAL STREPTOCOCCI RESULTS

STATION	FECAL COLIFORM /ml	FECAL STREPTOCOCCI /ml	RATIO	Expected source GEOGRAPHIC	Expected source BACTERIAL
35	490	130	3.77	human	human
36	130	330	0.39	human	animal*
44	0	45	0.02	animal	animal
52	0	130	0.01	human	animal
93	45	130	0.35	animal	animal*
108	230	1700	0.14	animal	animal
130	45	340	0.13	animal	animal
132	170	1100	0.15	animal	animal
156	0	45	0.02	animal	animal
176	45	0	4.5	human	human
185	3500	78	44.8	animal	human
186	790	330	2.39	animal	human *
247	2400	1300	1.85	animal	human *
249	230	3500	0.06	animal	animal
250	1300	220	5.91	animal	human
262	78	490	0.16	animal	animal
265	170	790	0.22	animal	animal
273	45	170	0.26	animal	animal
274	230	61	3.77	animal	human *
275	78	330	0.24	animal	animal
306	45	18	2.5	animal	human *
315	460	170	2.71	animal	human *
321	78	0	7.8	animal	human
345	1300	3300	0.39	animal	animal
353	490	140	3.5	human	human *
354	2800	16000	0.17	human	animal
355	490	3500	0.14	human	animal

* probable source

TABLE 5 - PSEUDOMONAS AERUGINOSA RESULTS

STATION	FECAL COLIFORM /ml	P. AERUGINOSA /ml	RATIO	Expected source GEOGRAPHIC	Expected source BACTERIAL
1	68	0	6.8	animal	animal
6	78	20	3.9	animal	animal
13	48	0	4.5	animal	animal
32	130	20	6.5	human	animal
34	1300	0	130.0	human	animal
35	490	0	49.0	human	animal
36	130	45	2.89	human	animal*
43	170	20	8.5	animal	animal
51	0	68	0.14	human	human
80	490	20	24.5	animal	animal
91	230	1300	0.17	animal	human
92	68	0	6.8	animal	animal
93	45	0	4.5	animal	animal
95	78	20	3.9	animal	animal
107	430	3500	0.12	animal	human
108	230	0	23.0	animal	animal
109	78	20	3.9	animal	animal
130	45	0	4.5	animal	animal
131	45	0	4.5	animal	animal
140	310	37	8.38	animal	animal
141	1300	0	130.0	animal	animal
142	170	0	17.0	animal	animal
173	310	1300	0.24	animal	human
174	330	20	16.5	animal	animal*
176	45	0	4.5	animal	animal
177	120	20	6.0	animal	animal
184	430	1300	0.33	animal	human
185	3500	0	350.0	animal	animal
186	790	0	79.0	animal	animal
216	310	3500	0.08	human	human
222	78	0	7.8	animal	animal
228	0	45	0.02	animal	human
246	330	110	3.0	animal	animal*
247	2400	0	240.0	animal	animal
248	1200	0	120.0	animal	animal
249	230	0	23.0	animal	animal
250	1300	20	65.0	animal	animal
261	230	18	12.7	animal	animal
263	230	0	23.0	animal	animal
264	140	0	14.0	animal	animal
265	170	0	17.0	animal	animal
266	68	0	6.8	animal	animal
271	230	68	3.38	animal	animal*
272	140	45	3.11	animal	animal*
273	45	0	4.5	animal	animal
274	230	0	23.0	animal	animal

*probable source

TABLE 5 CONTINUED

STATION	FECAL COLIFORM /ml	P. AERUGINOSA /ml	RATIO	Expected source GEOGRAPHIC	BACTERIAL
275	78	0	7.8	animal	animal
276	110	0	11.0	animal	animal
279	230	68	3.38	animal	animal
306	45	0	4.5	animal	animal
314	230	20	11.5	animal	animal
315	460	0	46.0	animal	animal
316	490	45	10.8	animal	animal
346	230	20	11.5	animal	animal
353	490	0	49.0	human	animal
354	2800	0	280.0	human	animal
355	490	20	24.5	human	animal
360	310	3500	0.09	animal	human
364	45	0	4.5	animal	animal

TABLE 6 - MONTHLY RAINFALL RESULTS

	RAINFALL IN INCHES
November 1980	.39
January 1981	.85
February 1981	1.76
March 1981	1.83
April 1981	.53
May 1981	7.14
June 1981	7.85
July 1981	1.97
August 1981	9.65
September 1981	1.80
October 1981	.81
November 1981	.92

*Data received from Environmental Center, Camp LeJeune, North Carolina and New River Air Station, Jacksonville, North Carolina

TABLE 7 - RESULTS OF 56 SURVEYS RETURNED FROM INDIVIDUAL FISHERMEN

ALL ANSWERS WILL BE KEPT CONFIDENTIAL

1. What is the nature of your activity in the New River area? (check all that apply)
   (18) swimming
   (34) recreational boating
   (50) recreational fishing and/or shellfishing
   (21) commercial fishing and/or shellfishing

2. Approximately how often do you use the New River for your activity?
N=29 (5.5)/month Range 1-15 (✓)/month-8
N=10 (12.1)/year Range 3-50 N/A-2 (✓)/year-5

3. Which general area do you usually use for your activity? (Refer to charts and/or maps)
(16)A (24)B (24)C (17)D (28)E (28)F (26)G (13)H (21)I (19)J (10)K (18)L (3) M (29)N N/A-1

4. How many years have you fished in this area? (15.6) years N/A 1 Range 3-35

5. For how many years in the future do you expect to fish in the New River area?
(20.5) years Life-17 Range 1-life

6. If you used a boat on your last trip: Type of boat ( )
   Length of boat (17.6)ft. Range 12-21
   Number in party (1.94) males (.6) females Σ = 2.54
   How many days spent in area on trip? (4.8) days N/A 14
   Is this your own boat? (55)yes ( )no N/A-1
   Did (will) you stay overnight in this county as a result of this trip?
   (21)yes (22)no N/A-3
   At a private residence (28)yes (9)no N/A-9
   Public lodging (7)yes (25)no N/A-15

7. Approximately what were the total expenses incurred on this trip in Onslow County?
   (41) 0-$50 (83%) (4) $100-$500 (8%) (1) over $1000 (2%)
   (3) $50-$100 (6%) ( ) $500-$1000 N/A-7

8. Where do you usually launch your boat? (12) private (21%) (33) public (6%) Both-10 (18%) N/A-1

9. What is the approximate value of your boat and gear?
   (2) less than $500 (4%) ( ) $20,000-$50,000
   (14) $500-$1000 (25%) ( ) $50,000-$100,000
   X̄=3536 (32) $1000-$5000 (57) (1) $100,000-$500,000 (2%)
   (7) $5000-$20,000 (1.25%) ( ) more than $500,000

10. How much have you spent in the last 12 months on boat expenses and gear?
   (6) less than $100 (11%) (2) $5000-$20,000 (4%)
   (29) $100-$500 (52%) ( ) $20,000-$50,000
   (9) $500-$1000 (16%) ( ) more than $50,000
   (10) $1000-$5000 (18%)

11. If fishing...what percent:

sport or recreational	commercial
(2) 0-5 (4%)	(8) 0-5 (51%)
(7) 5-10 (14%)	(3) 5-10 (11%)
(7) 10-25 (14%)	(3) 10-25 (11%)
(5) 25-50 (9%)	(3) 25-50 (11%)
(7) 50-75 (14%)	(3) 50-75 (11%)
(24) 75-100 (16%)	(6) 75-100 (23%)

12. Is your catch sold? (10) yes (19%) (44) no (81%) N/A-2

13. Approximately how many pounds did your total catch weigh during the past 12 months?

(16) 0-100 (29%)	(2) 500-10,000 (4%)
(32) 100-500 (58%)	(1) 10,000-20,000(2%) N/A-1
(3) 500-1000 (5%)	( ) 20,000-50,000
(1) 1000-5000 (2%)	( ) more than 50,000

14. Is your fishing activity for a particular species? (17)yes (31%) (37)no (69%) N/A-2

15. What type of fishing gear and method do you usually use? (Check all that apply)

gear	method
(43)pole and line	(23) trawling
(47)gill net	(29) still fishing
(11) seine	(39) drifting
(14) cast net (bait)	(36) casting
(20) rake, tong	(1)other Shrimp Trawl (20 ft net)
(27) gig	(1) Setting net
(3) dredge	
(2) other Crab Pot	
(1) Eel Pot	

16. If you knew in advance that you wouldn't have caught anything in the bay area today, how much money would you have spent on some other activity in Onslow County?

(31) $0-10 (63%)	(1)$100-$300 (2%)
(15) $10-$50 (31%)	( )$300-$500 N/A-7
(1) $50-$100 (2%)	(1) more than $500 (2%)

17. What is your occupation? ( )

18. Would you indicate which catagory most closely corresponds to your income for the past 12 months?

(6)less than $5000 (12%)	(8)$20,000-$30,000 (15%)
(7)$5000-$10,000 (13%)	(5)$30,000-$40,000 (9%) N/A-4
(16)$10,000-$15,000 (31%)	(1)$40,000-$50,000 (2%)
(9)$15,000-$20,000 (17%)	( ) more than $50,000

19. Comments on improving the use of the New River

6. Type of boat

Skiff - 13
Fiberglass - 3
Trihull - 2
Wood - 2
Allendale - 2
Aluminum - 2
Bass - 2
Well boat
Open whaler
Cruiser
McKee craft
Phillips
Dixie
I-O
Manatee
Porter
Outboard
Canoe
Atlantic
Trawler (80 ft.)
Pleasure

N/A - 16

17 Occupation

Veterinarian
Dentist
Principal
Teacher
Civil Service - 2
Salesman - 2
Manager - radio station
Office Manager
Plant manager - Oil Co.
Insurance agent
Parts manager
Life insurance salesman
Merchant
Store clerk
Production leader
N.C. Marine Fisheries
Telephone Co. - 4
Construction worker - 2
Fireman
Industry
Lineman
Electrician
Courier
Welder
Painter
Heavy equipment operator
Refrigeration
General maintenance person
DVAA assistant
Auto mechanic
Bait and tackle shop
Body repairman
Fishermen - 3
Farmer
Unspecified - 5
Student
Unemployed
Retired - 9

N/A - 2

The average boat, valued at $3,536, is 17.6 feet long and carries an average party of 1.94 males and 0.6 females. The average trip is 4.8 days and at least half respondents either will live or stay overnight in the county. Of the 56 respondents, 55 own their boats. Public boat ramps are used by 60% of the respondents, 21% prefer private ramps and 18% use both types. Over 80% of the respondents spent less than $50 per trip. In the past twelve months, those polled (52%) spent an average of $100-500 on boat expenses and gear.

Sport fishermen comprised 46% of the respondents and only 19% sell their catch. Thirty-two of 52 (58%) caught between 100-500 pounds of fish this year with only one over 10,000 pounds. Fishermen were generally after no specific catch (69%). Gill nets and pole and line are the predominant gear with drifting and casting being the method most often used in the river.

Although it is difficult to determine the amount of money spent in the county on a trip, most of the respondents (63%) felt that they would have spent up to $10 in Onslow County if they knew they would not catch anything on the trip. The occupation of the respondents is diverse. Of the respondents, 31% had incomes between $10,000 -15,000 and only one exceeds $40,000.

DISCUSSION AND CONCLUSIONS

In this study we tried to determine the impact of fecal pollution on the New River Estuary. We attempted to assess the coliform bacteria distribution and tried to define point and non-point sources of pollution in the estuary. During the 1980-1981 sample year, high coliform levels occurred around the city of Jacksonville, Northeast Creek and in the head waters of all the smaller creeks; lower levels occured in the bay. We postulated at the beginning of the study and our data showed that the high coliform counts around Jacksonville are due to increased population. The reduced numbers in the bay areas are probably due to high tidal fluxuation and greater depth of the water. Another possible explanation of the low coliform counts in the bay is debilitation and dilution of the bacteria . When the bacteria enter salt water, they become stressed, will not grow on selective media and are out-competed by the other bacteria (Dawe and Penrose, 1978).

The bacterial composition of the sewage outfalls in the New River were examined. Fecal and total coliform counts were below the EPA-acceptable limits of 79 MPN for Class C waters (EPA,1978) in all areas except Wilson Bay. Class C water is acceptable for sewage outfalls, fishing, agriculture and secondary recreation but not for drinking, food preparation or primary recreation. In Wilson Bay, increased fecal coliform counts are attributed to the resuspension of bottom sediments by current agitation and a concomitant release of sediment-bound fecal coliforms and kennel runoff. An indepth study of sediments in this bay is highly recommended.

Our data indicate that the outfalls are not the primary source of

coliform pollution in the river and that the present discharge system is acceptable. Any large increase in the human population, such as would happen with expanded land development, could tax the sewage system. Growth in this area should be accompanied by evaluation of the capability of all existing sewage disposal and septic systems handling wastes. Sources contributing significantly to the high coliform counts in the river are land runoff, wildlife and sanitary landfills (Northeast Creek). Salinities were poorly correlated with the total coliform and fecal coliform numbers found at stations throughout the estuary thus, salinity was not thought to be important in this estuary. Similar results were found with temperature, but rainfall showed a relationship. We therefore feel that rain is the main influence on coliform counts in this estuary.

We think that sources other than sewage outfalls are the main cause of coliform pollution in the New River. It appears that agricultural use, extensive forest land and the presence of the Camp Lejeune Marine Base effect bacterial densities in the bay. Specific local activities observed during the study which are thought to influence the bacterial densities include:

1) U.S. Marine field exercises
2) Extensive deer herds
3) Domestic animals in the agricultural areas
4) Increased runoff volume as a result of the removal of natural ground cover for construction activities.

The results of the analysis for fecal streptococci and *Pseudomonas aeruginosa* support this theory. If the fecal streptococci to fecal coliform ratio is greater than four, it indicates domestic

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

The [illegible]

[illegible]

[illegible]

sewage and ratios of 0.6 indicate animal-related coliforms. This ratio indicates the source of coliforms in the New River is probably animal (Table 3).

In this study of the New River, our data resembles Cabelli's (1976) data from Lake Michigan. In both the New River and Lake Michigan, the Pseudomonas aeruginosa counts when related to fecal coliform indicate the pollution source. If Pseudomonas aeruginosa is low and fecal coliform is high, the source is again believed to be animal. Table 4 further supports the hypothesis that the New River coliform is of animal origin.

In this study, the total coliform counts rise to a high during February then diminish to a low in April. The counts rise again in June, drop in July and climb in August. The counts remain high in the fall and drop as winter begins. This pattern holds true for all areas except Stones Bay, where the counts are low throughout the year with a peak in late summer and again in the late fall. The fecal coliform counts follow the same pattern as the total coliform throughout the year. The only major exception is in Stones Bay in mid fall when the counts rise and then drop again in late October before they rise in late November. This seasonal change did not appear to be related to temperature, that is no correlation was found, however, it was related to the amount of rainfall. During the sample year, the highest monthly rainfall accumulations were in May, June and August with a correspondingly high bacterial count due to increased land runoff. This pattern does not apply to Stones Bay where the dilution is already high so the increased runoff has little or no effect.

The magnitude and value of assorted water-related activities on ence and cattle [illegible]

rcentage [illegible]

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[illegible]

the New River is unknown. However, undesirable levels of fecal coliform in the New River would certainly create countywide economical and sociological problems. The impact of closing of the river to commercial and recreational activities is presently unknown. Therefore, a survey was utilized to evaluate the potential economic losses of closing the river to Onslow County residents. Out of 1200 potential users, the 56 (5%) who responded to the questionnaire were used to give an indication of the use of the river. The majority of the respondents use the river for commercial or recreational fishing. Half of the respondents use the river an average of 5.5 times per month and 17% use it one time per month. Using these percentages we estimated that approximately 1000 persons use the river at least once per month.

The New River estuary has been used extensively for recreational boating, crabbing and fishing and as the local population increases, recreational use of the area will also likely increase. More than 20,000 people per year use the Camp Lejeune Marina alone. Based upon a recent Jacksonville survey, which has been accepted as representative of Onslow County (Horace Mann, 1981) at least 14% of the population is involved in boating and another 12.5% would like to do so. Additionally, 34.5% of the population of Jacksonville actively fish on the New River, with an additional 14.3% desiring to do so. Finally the seafood harvesting and processing industries add approximately $10,000,000 to the economy of Onslow County (CAMA, 1980).

Any increase in the present high bacterial levels, and in fact, the present level of contamination, would be detrimental to

the [illegible]
politi[illegible]
and [illegible]
commercial [illegible]
Therefor[illegible]
loss [illegible]
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used [illegible]
the [illegible]
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m[illegible]
est[illegible]
p[illegible]

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recreational and commercial uses of the New River. For example, during the last part of April, 1981, the river was closed to human immersion, fishing and crabbing by order of the N.C. Shellfish Sanitation Department. This resulted in decreased public spending for recreational activities and loss of income to local commercial fishermen.

Analysis of field and laboratory data collected during this study on bacteriological contamination of the New River, Onslow County, N.C., has led to the following conclusions:

1) High total coliform and fecal coliform counts appear to be concentrated around the populated areas of Jacksonville City and in Northeast, Frenchs Creeks and in Wilson Bay.
2) Most coliform counts appeared to be from non-point sources and could be attributable to run-off from agricultural pastures, wildlife and sanitary landfills.
3) Fecal streptococci and Pseudomonas aeruginosa data indicate that the non-point coliform pollution is most likely of an animal origin.
4) Seasonal patterns of coliform distribution showed peaks in February, June and August, probably due to increased rainfall during these months.
5) Increased counts of coliform bacteria will be detrimental to recreational and commercial use of the New River watershed area, while decreased counts will tend to benefit its socio-economic growth and stability.

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Key Code to Appendix I

Sta	Station Number Identifer Code
S	Salinity (0/00)
Tur	Turbidity (FTU)
At	Air Temperature (°C)
Wt	Water Temperature (°C)
Lt	Lauryl Tryptose broth
BGB	Brillant Green Bile broth
EC	EC broth
EMB	Eosine Methylene Blue Agar
Asp	Asparagine broth
Act	Acetamide Agar
AZD	Azide Dextrose broth
EVA	Ethyl Violet Azide broth
Vib	Vibrio sp.
D.O.	Dissolved Oxygen (ppm)

Appendix I is summary data from November 30, 1980 to December 7, 1981, New River Estuary

APPENDIX I

	#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
A	1	SCB $12/7_{5}\mathrm{I}$	0	45	13	9.0	490	220	68	110	45	0	220	93	0	19
	2	SCB $1/9_{1}\mathrm{I}$	0	95cm	8	5.2	2400	790	490	270	-	-	-	-	-	-
	3	SCB $3/18_{12}\mathrm{I}$	1	30	19	13	320	110	45	68	-	-	-	-	-	-
	4	SCB $6/11_{13}\mathrm{I}$	0	110	28	39	9200	3500	78	68	-	-	-	-	-	-
	5	SCB $7/10_{14}\mathrm{I}$	1	55	32	30.5	790	490	100	68	-	-	-	-	-	6.7
	6	SCB $8/29_{10}\mathrm{I}$	0	26	30	23	2800	1800	78	92	92	20	-	-	-	4.8
	7	SCB $11/30_{1}\mathrm{I}$	0	45	0.5	9.5	3200	920	170	540	-	-	-	-	-	-
	8	SCB $3/18_{11}\mathrm{I}$	3	30	18	12	490	110	78	45	-	-	-	-	-	-
	9	SCB $6/11_{12}\mathrm{I}$	0	79	38	29	480	340	45	140	-	-	-	-	-	-
	10	SCB $7/10_{13}\mathrm{I}$	1	45	32	30	5400	5400	68	130	-	-	-	-	-	6.8
	11	SCB $6/11_{11}\mathrm{I}$	0	105	37	27	5400	1100	130	210	-	-	-	-	-	-
	12	SCB $7/10_{12}\mathrm{I}$	1	45	33	30	790	790	20	68	-	-	-	-	-	6.8
	13	SCB $8/29_{9}\mathrm{I}$	0	30	29	23	790	490	45	0	0	0	-	-	-	4.5
	14	SCB $1/9_{2}\mathrm{I}$	0	61	8	5.2	3500	1700	230	490	-	-	-	-	-	-
	15	SCB $3/18_{13}\mathrm{I}$	4	30	20	11.5	790	490	45	78	-	-	-	-	-	-
	16	SCB $8/29_{8}\mathrm{I}$	0	55	35	28	16000	5400	68	68	-	-	-	-	-	-
	17	SCB $7/10_{11}\mathrm{I}$	4	75	33	34	24000	5400	45	68	-	-	-	-	-	6.7
	18	SCB $8/29_{8}\mathrm{I}$	0	30	30	24	1700	790	20	83	0	0	-	-	-	5.1
	19	SCB $11/30_{2}\mathrm{I}$	0	18	18	7.6	3200	3200	920	29	-	-	-	-	-	-
	20	SCB $1/9_{4}\mathrm{I}$	0	-	6	5	3200	3200	1100	1400	-	-	-	-	-	11.0
	21	SCB $3/18_{14}\mathrm{I}$	2	38	20	11	1300	110	40	20	-	-	-	-	-	-
B	22	SCB $1/9_{5}\mathrm{I}$	0	58	4.5	4.2	9200	3500	460	170	-	-	-	-	-	10.8
	23	SCB $2/28_{1}\mathrm{I}$	2	40	19	11	790	330	130	330	-	-	-	-	-	-
	24	SCB $3/18_{9}\mathrm{I}$	8	25	18	12	1700	45	40	0	-	-	-	-	-	-
	25	SCB $3/18_{10}\mathrm{I}$	6	35	18	12	220	45	20	20	-	-	-	-	-	-
	26	SCB $5/13_{1}\mathrm{I}$	0	-	24	23	24000	24000	16000	320	-	-	-	-	-	-
	27	SCB $6/11_{9}\mathrm{I}$	0	90	34	28	2400	790	20	130	-	-	-	-	-	-
	28	SCB $6/30_{1}\mathrm{I}$	3	70	28	27	2400	2400	1300	270	-	-	-	-	-	-
	29	SCB $7/10_{10}\mathrm{I}$	4	35	33.5	31.5	9200	260	0	40	-	-	-	-	-	6.6
	30	SCB $7/24_{1}\mathrm{I}$	8	20	30	30	1600	5400	230	20	1300	-	-	-	-	-

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
31	SCB $8/20_{1}$I	2	75	23	22	24000	24000	230	140	700	170	-	-	-	7.5
32	SCB $8/29_{11}$I	2	32	29	24.5	1300	790	130	130	45	20	-	-	-	4.9
33	SCB $9/25_{1}$I	5	-	25	21	3500	1300	20	120	0	0	700	20	1	-
34	SCB $10/12_{1}$I	4	-	24	16	3500	3500	1300	1700	0	0	1300	1300	2	-
35	SCB $10/31_{0}$I	21	110	17.5	16	1700	1700	490	1700	0	0	2400	130	TNTC	-
36	SCB $11/15_{1}$I	18	26	15	11	16000	3500	130	330	45	45	490	330	15	-
37	SCB $12/7_{4}$I	12	40	14.0	9.0	78	45	0	0	0	0	0	0	0	19
C 38	SCB $11/30_{3}$I	2	55	2.2	8.6	3200	3200	540	52	-	-	-	-	-	72
39	SCB $1/9_{6}$I	0	55	5	4.3	9200	5400	790	170	-	-	-	-	-	11.7
40	SCB $3/18_{8}$I	8	30	17	12	490	170	45	68	-	-	-	-	-	-
41	SCB $6/11_{8}$I	0	105	34	29	5400	3500	45	170	-	-	-	-	-	-
42	SCB $7/10_{9}$I	5	35	33.5	31	3500	490	230	230	-	-	-	-	-	6.5
43	SCB $8/29_{6}$I	0	29	28	25	2400	1300	170	93	45	20	-	-	-	5.2
44	SCB $12/7_{3}$I	15	20	15	9	130	130	0	45	0	0	78	45	0	19
45	SCB $1/9_{7}$I	0	58	5.5	4	32000	2400	330	170	-	-	-	-	-	-
46	SCB $3/18_{6}$I	9	35	17	11	1100	1100	140	170	-	-	-	-	-	-
47	SCB $3/18_{7}$I	8	33	17	11	490	230	45	130	-	-	-	-	-	-
48	SCB $6/11_{6}$I	1	50	36	29	24000	16000	5400	450	-	-	-	-	-	-
49	SCB $7/10_{7}$I	8	45	32	30.5	490	170	0	40	-	-	-	-	-	6.6
50	SCB $7/10_{8}$I	9	35	33	31	790	790	20	20	-	-	-	-	-	6.6
51	SCB $8/29_{5}$I	4	28	28	26	700	460	0	40	68	68	-	-	-	6.0
52	SCB $12/7_{2}$I	9	55	15.5	9.5	330	170	0	78	20	0	230	130	0	19
53	SCB $11/30_{4}$I	7	50	6.7	8.8	350	180	130	280	-	-	-	-	-	87
54	SCB $6/11_{5}$I	1	80	36	28	2400	1300	78	130	-	-	-	-	-	-
55	SCB $8/29_{4}$I	4	30	30	26	330	330	0	0	20	0	-	-	-	5.3
56	SCB $7/10_{6}$I	12	30	31.5	31	490	330	20	20	-	-	-	-	-	6.6
57	SCB $4/15_{1}$I	10	10	19	22	490	140	0	40	-	-	-	-	-	-
58	SCB $10/31_{2}$I	18	85	17	16.5	45	45	0	0	0	0	78	0	TNTC	-
59	SCB $11/15_{2}$I	23	17	15	12	2200	1300	170	340	220	220	220	140	8	-
60	SCB $1/9_{8}$I	6	60	5.5	5.1	5400	330	50	80	-	-	-	-	-	14.5

APPENDIX I

	#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
	61	SCB 3/18$_5$I	15	21	17	11	110	110	110	68	-	-	-	-	-	-
	62	SCB 8/29$_2$I	4	70	39	29	9200	3500	68	140	-	-	-	-	-	-
	63	SCB 8/29$_2$I	3	26	27	25	1100	790	20	61	45	45	-	-	-	5.9
E	64	SCB 7/10$_5$I	12	30	32	30.5	0	0	0	0	-	-	-	-	-	6.7
	65	SCB 12/7$_1$I	18	20	14	9.5	20	20	0	0	0	0	20	0	0	16
F	66	SCB 3/18$_3$II	14	10	17	11	170	68	68	40	-	-	-	-	-	-
	67	SCB 6/11$_3$II	3	55	32	30	1300	1300	45	78	-	-	-	-	-	-
	68	SCB 7/10$_3$II	7	20	33	31.5	110	68	0	45	-	-	-	-	-	6.6
	69	SCB 8/29$_2$II	10	15	27	25.5	3500	1100	45	93	45	45	-	-	-	6.3
	70	SCB 4/15$_1$II	4	12	19	18	2200	950	0	640	-	-	-	-	-	-
	71	SCB 2/28$_3$II	0	20	18	11	270	170	20	110	-	-	-	-	-	-
	72	SCB 1/9$_3$II	-	-	-	4.2	330	230	0	50	-	-	-	-	-	-
	73	SCB 3/18$_4$II	12	16	16	11	45	20	0	20	-	-	-	-	-	-
	74	SCB 3/18$_5$II	12	15	16	11	0	0	0	0	-	-	-	-	-	-
	75	SCB 6/11$_2$II	7	37	35	29	330	130	20	45	-	-	-	-	-	-
	76	SCB 7/10$_4$II	10	35	33	30	130	130	0	78	-	-	-	-	-	6.6
	77	SCB 7/24$_3$II	0	15	27	22	24000	16000	790	61	-	-	-	-	-	-
	78	SCB 6/11$_5$II	3	55	32	30	1300	1300	45	78	-	-	-	-	-	-
	79	SCB 7/10$_5$II	9	30	32	31.5	170	68	0	18	-	-	-	-	-	6.5
	80	SCB 8/29$_4$II	9	18	27	25	3500	3500	490	490	40	20	-	-	-	6.2
	81	SCB 1/9$_4$II	-	-	-	5.2	3500	490	50	40	-	-	-	-	-	-
	82	SCB 2/4$_1$II	0	85	-1	4	24000	24000	24000	-	-	-	-	-	-	-
	83	SCB 2/28$_2$II	5	45	19	13.5	1300	490	78	220	-	-	-	-	-	-
	84	SCB 3/18$_6$II	6	17	16	11.5	490	490	20	220	-	-	-	-	-	-
	85	SCB 4/15$_2$II	9	5	19	23	5400	3500	0	74	-	-	-	-	-	-
	86	SCB 5/13$_3$II	4	-	27	26	9200	9200	330	200	-	-	-	-	-	-
	87	SCB 6/11$_6$II	0	80	33	29	5400	1400	230	130	-	-	-	-	-	-
	88	SCB 6/30$_4$II	6	55	29	27	24000	3400	110	93	-	-	-	-	-	-
	89	SCB 7/10$_6$II	7	30	32	31.5	3500	1100	78	68	-	-	-	-	-	6.6
	90	SCB 7/24$_1$II	8	35	27	30	24000	9200	230	0	2400	-	-	-	-	-

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
91	SCB $8/20_{5}$II	1	190	22	22	24000	24000	230	380	1300	1300	-	-	-	5.3
92	SCB $9/25_{2}$II	5	-	25	23	1700	790	68	40	0	.0	230	45	42	15.5
93	SCB $10/12_{1}$II	14	-	24.5	19	9200	3500	45	110	170	0	330	130	0	-
94	SCB $10/31_{1}$II	19	160	21	16	110	110	20	110	0	0	330	0	TNTC	-
95	SCB $11/15_{3}$II	20	29	17	12	9200	3500	78	330	40	20	140	93	8	-
96	SCB $1/21_{2}$II	0	5	10	8	16000	9200	790	450	-	-	-	-	-	-
97	SCB $5/27_{5}$II	1	60	24	20	1700	1300	230	330	-	-	-	-	-	-
98	SCB $1/21_{3}$II	0	30	10	8	230	230	230	230	-	-	-	-	-	-
99	SCB $5/27_{4}$II	1	50	24	20	2400	790	78	170	-	-	-	-	-	-
100	SCB $5/27_{3}$II	1	120	23	20	5400	3500	1300	790	-	-	-	-	-	-
101	SCB $1/21_{4}$II	0	165	10	9	32000	16000	5400	1400	-	-	-	-	-	-
102	SCB $5/27_{2}$II	2	85	23	20	2200	640	0	0	-	-	-	-	-	-
103	SCB $2/4_{2}$II	11	45	-2	7	24000	24000	3500	810	-	-	-	-	-	-
104	SCB $4/15_{8}$II	15	0	21	23	230	20	0	20	-	-	-	-	-	-
105	SCB $5/27_{6}$II	20	40	22	24	130	78	0	20	-	-	-	-	-	-
106	SCB $7/24_{1}$II	14	10	18.5	30	700	700	20	0	-	-	-	-	-	-
107	SCB $8/20_{4}$II	10	50	22	23.5	24000	24000	430	200	16000	3500	-	-	-	6.2
108	SCB $10/31_{2}$II	5	110	20	16.5	1300	490	230	490	0	0	1700	1700	7	-
109	SCB $11/15_{2}$II	21	18	15	10	790	490	78	170	40	20	78	78	1	-
110	SCB $2/28_{4}$II	12	30	19	12	130	45	20	45	-	-	-	-	-	14
111	SCB $3/18_{2}$II	13	19	13	10.5	130	130	20	130	-	-	-	-	-	-
112	SCB $6/11_{1}$I	5	50	37.5	28	3500	120	0	18	-	-	-	-	-	-
113	SCB $7/10_{1}$I	13	20	30	30	45	20	0	20	-	-	-	-	-	6.5
114	SCB $8/29_{1}$I	5	20	27	25.5	490	230	0	78	20	0	-	-	-	8.3
115	SCB $11/30_{5}$I	5	45	8.4	6.2	1600	1600	350	920	-	-	-	-	-	69
116	SCB $1/9_{10}$I	0	28	5	2.8	5400	200	20	60	-	-	-	-	-	11.4
117	SCB $3/18_{1}$I	10	15	13	11	460	45	0	45	-	-	-	-	-	-
118	SCB $7/10_{2}$I	9.	20	30.5	30	790	490	20	110	-	-	-	-	-	6.5
119	SCB $6/29_{2}$I	3	26	27	25	1100	790	20	61	45	45	-	-	-	5.9
120	SCB $12/7_{1}$I	18	20	14.0	9.5	20	20	0	0	0	0	20	0	0	16

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	A7D	EVA	Vib	D.O
121	SCB 3/18$_2$I	6	15	12	17	130	45	0	45	-	-	-	-	-	-
122	SCB 6/11$_2$I	2	60	39	30	1300	79	20	37	-	-	-	-	-	-
123	SCB 7/10$_3$I	8	35	31	30	2400	1300	78	78	-	-	-	-	-	6.6
124	SCB 3/18$_3$I	4	16	16	1.5	270	61	0	20	-	-	-	-	-	-
125	SCB 6/11$_3$I	1	60	39	29	1300	490	68	40	-	-	-	-	-	-
126	SCB 7/10$_4$I	6	35	31.5	30	3500	3500	45	120	-	-	-	-	-	6.7
127	SCB 5/27$_3$I	1	60	22	20	790	490	40	68	-	-	-	-	-	-
128	SCB 5/27$_2$I	1	50	22	20	2400	1300	230	490	-	-	-	-	-	-
129	SCB 8/20$_2$I	1	120	23	21	24000	24000	230	92	9200	3500	-	-	-	5
130	SCB 10/12$_2$I	0	-	27	16.5	3500	3500	45	92	790	0	24000	340	90/10	-
131	SCB 10/31$_1$I	0	55	18	16	93	68	45	68	0	0	0	78	0	-
132	SCB 11/15$_3$I	1	22	16	12	3500	2400	170	170	490	93	5400	1100	0	-
133	SCB 1/17$_1$I	0	-	2	2	1700	220	170	170	-	-	-	-	-	-
134	SCB 1/21$_1$I	0	30	10	10	3500	1300	790	1300	-	-	-	-	-	-
135	SCB 2/28$_2$I	0	30	22	10	-	-	-	-	-	-	-	-	-	-
136	SCB 4/29$_1$I	0	5	-	20	490	170	20	68	-	-	-	-	-	-
137	SCB 5/27$_1$I	1	120	24	19	2400	2400	790	1300	-	-	-	-	-	-
138	SCB 4/30$_2$I	1	35	29	19	5400	2200	1100	330	-	-	-	-	-	-
139	SCB 7/24$_2$I	0	55	30	25	2800	2800	330	460	220	-	-	-	-	-
140	SCB 8/20$_3$I	0	110	23	225	24000	16000	310	440	37	37	-	-	-	6
141	SCB 10/12$_1$I	4	-	23	16	3500	3500	1300	1700	0	0	1300	1300	2	-
142	SCB 4/15$_4$I	0	16	15	11	16000	5400	170	5400	0	0	110	110	3	-
G 143	SCB 2/4$_3$II	0	20	-2	4.5	24000	24000	720	810	-	-	-	-	-	-
144	SCB 4/15$_7$II	0	10	23	20	2400	1300	0	170	-	-	-	-	-	-
145	SCB 5/27$_7$II	1	50	23	21	5400	5400	330	220	-	-	-	-	-	-
146	SCB 7/24$_3$II	0	15	27	22	24000	16000	790	61	-	-	-	-	-	-
147	SCB 2/4$_4$II	0	10	0	5	24000	720	150	190	-	-	-	-	-	-
148	SCB 4/15$_6$II	0	17	23	21	2200	2200	0	1100	-	-	-	-	-	-
149	SCB5/27$_8$II	1	35	23	23	1100	790	490	490	-	-	-	-	-	-
150	SCB 7/24$_4$II	0	20	28	26	24000	16000	1300	36	-	-	-	-	-	-

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
151	SCB $2/28_{5}$II	12	30	18	11	68	45	45	45	-	-	-	-	-	-
152	SCB $3/18_{1}$II	13	17	13	11	20	20	20	0	-	-	-	-	-	-
153	SCB $6/11_{2}$II	7	39	35	29	330	130	20	45	-	-	-	-	-	-
154	SCB $7/10_{2}$II	0	25	27	25	24000	24000	1300	200	-	-	-	-	-	-
155	SCB $8/29_{1}$II	9	17	27	25.5	78	78	0	78	-	-	-	-	-	9
156	SCB $9/12_{2}$II	10	5	27	25	220	130	0	20	20	20	230	45	0	6.4
157	SCB $2/28_{2}$II	5	45	19	13.5	1300	490	78	220	-	-	-	-	-	-
158	SCB $3/28_{5}$II	175	-	19	11	2200	2200	0	2200	-	-	-	-	-	-
159	SCB $4/29_{1}$II	17	3	25	21.5	130	0	0	0	-	-	-	-	-	-
H 160	SCB $11/30_{1}$II	12	50	9	8.4	3200	3200	3200	50	-	-	-	-	-	-
161	SCB $2/4_{4}$II	4	50	0	6.5	24000	24000	810	810	-	-	-	-	-	-
162	SCB $2/4_{9}$II	4	50	1	6	24000	24000	720	810	-	-	-	-	-	-
163	SCB $3/28_{1}$II	10	-	12	13	460	460	20	68	-	-	-	-	-	-
164	SCB $3/28_{6}$II	15	-	22	16	490	220	20	220	-	-	-	-	-	-
165	SCB $4/15_{5}$II	15	15	20	22	230	130	0	45	-	-	-	-	-	-
166	SCB $5/13_{1}$II	9	-	26	27	490	330	0	45	-	-	-	-	-	-
167	SCB $5/13_{2}$II	4	-	24	24	210	210	20	40	-	-	-	-	-	-
168	SCB $5/27_{9}$II	20	20	24	25	20	20	0	20	-	-	-	-	-	-
169	SCB $6/11_{1}$II	4	40	32	31	490	230	45	78	-	-	-	-	-	-
170	SCB $6/30_{1}$II	10	50	23	27	490	330	0	45	-	-	-	-	-	-
171	SCB $7/10_{1}$II	8	20	29	31	230	230	0	0	-	-	-	-	-	7.4
172	SCB $7/24_{5}$II	12	15	27	29	1700	460	78	0	3400	-	-	-	-	-
173	SCB $8/20_{1}$II	4	70	21	22	24000	16000	310	61	1300	1300	-	-	-	5.5
174	SCB $8/29_{5}$II	10	10	30	25	5400	470	330	170	45	20	-	-	-	5.3
175	SCB $9/12_{1}$II	10	10	27	26	2400	490	20	20	45	45	460	20	TNTC	6.5
176	SCB $10/31_{3}$II	19	70	20	17	220	220	45	140	0	0	130	0	100	-
177	SCB $11/15_{1}$II	21	18	16	10	3500	3500	120	210	45	20	490	68	0	-
178	SCB $2/4_{7}$II	2	46	2	6.5	24000	24000	640	24000	-	-	-	-	-	-
179	SCB $2/28_{1}$II	0	30	15	11	230	230	78	230	-	-	-	-	-	-
180	SCB $4/15_{3}$II	4	17	22	20	9200	9200	0	5400	-	-	-	-	-	-

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
181	SCB 4/29$_3$II	4	8	25	23.5	330	330	130	130	-	-	-	-	-	-
182	SCB 6/30$_3$II	7	50	23	26	24000	24000	1300	410	-	-	-	-	-	-
183	SCB 7/24$_6$II	1	50	29	27	24000	4300	230	0	2400	-	-	-	-	-
184	SCB 8/20$_2$II	1	100	21	22	24000	24000	430	210	3500	1300	-	-	-	5.4
185	SCB 9/25$_1$II	1	-	27	21	16000	16000	3500	16000	0	0	230	78	1	-
186	SCB 10/12$_2$II	10	-	25	20	16000	9200	790	470	92	0	330	330	47	-
187	SCB 2/4$_6$II	0	22	1	5	24000	24000	720	810	-	-	-	-	-	-
188	SCB 4/15$_1$II	4	12	19	18	2200	950	0	640	-	-	-	-	-	-
189	SCB 6/30$_5$II	0	60	26	23	5400	5400	1300	2400	-	-	-	-	-	-
G 200	SCB 2/28$_4$II	12	30	19	12	130	45	20	45	-	-	-	-	-	-
201	SCB 2/28$_3$II	0	20	18	11	270	170	20	110	-	-	-	-	-	-
202	SCB 3/28$_1$II	10	-	12	13	460	460	20	68	-	-	-	-	-	-
203	SCB 4/29$_2$II	19	8	25	21	1700	1700	1700	0	-	-	-	-	-	-
204	SCB 6/30$_2$II	10	35	23	26.5	640	210	20	20	-	-	-	-	-	-
205	SCB 12/7$_1$II	22	35	14	8.5	0	0	0	0	0	0	0	0	0	15
I 206	SCB 9/12$_1$III	11	10	26	26	220	45	0	45	0	0	230	20	+	6.9
207	SCB 12/7$_6$ III	22	12	13.5	9	20	20	0	0	0	0	230	0	0	17
208	SCB 11/30$_2$III	22	-	8.8	9	33	17	8	11	-	-	-	-	-	-
209	SCB 3/28$_1$III	21	-	13	12.5	78	78	0	78	-	-	-	-	-	-
210	SCB 3/28$_8$III	19	-	18	11.5	0	0	0	0	-	-	-	-	-	-
211	SCB 4/29$_1$III	20	0	25	22	78	0	0	0	-	-	-	-	-	-
212	SCB 6/30$_1$III	12	25	22.5	26	170	45	20	20	-	-	-	-	-	-
213	SCB 2/4$_1$III	0	88	-1.5	4	24000	24000	320	24000	-	-	-	-	-	-
214	SCB 5/13$_1$III	0	-	26	25	460	68	0	20	-	-	-	-	-	-
215	SCB 7/24$_1$III	0	20	27	27	9200	9200	790	68	-	-	-	-	-	-
216	SCB 8/20$_1$III	0	320	22	22	24000	24000	310	61	3000	3500	-	-	-	4.8
217	SCB 11/30$_1$III	-	-	8.5	9	5	2	2	2	-	-	-	-	-	-
218	SCB 2/28$_3$III	15	30	16	11	78	45	20	20	-	-	-	-	-	-
219	SCB 2/28$_5$III	15	15	18	13	20	0	0	0	-	-	-	-	-	-
220	SCB 3/28$_7$III	21.5	-	20	15.5	45	45	18	45	-	-	-	-	-	-

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
221	SCB $6/30_2$III	13	40	26	26	490	330	0	0	–	–	–	–	–	–
222	SCB $9/12_2$III	115	7	28	26.5	220	170	78	78	18	0	230	0	+	6.2
223	SCB $12/7_5$III	22	10	12.5	8.5	0	0	0	0	0	0	0	0	0	16
K 224	SCB $2/28_2$III	15	22	15	13	0	0	0	0	–	–	–	–	–	–
225	SCB $2/28_6$III	17	25	18	13	0	0	0	0	–	–	–	–	–	–
226	SCB $3/28_2$III	18	–	13	12.2	230	130	45	130	–	–	–	–	–	–
227	SCB $4/29_2$III	21	1	26	22	230	0	0	0	–	–	–	–	–	–
228	SCB $9/12_3$III	11	8	27	16	490	220	0	68	230	45	130	20	+/+	6.6
229	SCB $12/7_4$III	25	10	12	8	0	0	0	0	0	0	0	0	0	14
230	SCB $11/30_1$IV	4	75	8.8	9	1600	1600	540	920	–	–	–	–	–	–
231	SCB $2/28_8$IV	14	20	17	14	20	18	0	18	–	–	–	–	–	–
232	SCB $2/28_9$IV	12	15	16	14	140	45	45	20	–	–	–	–	–	–
233	SCB $3/28_1$IV	10	–	15	13.5	1800	1800	18	1800	–	–	–	–	–	–
234	SCB $4/29_1$IV	20	5	26	22	230	0	0	0	–	–	–	–	–	–
235	SCB $6/30_3$IV	15	35	29	26	950	160	0	0	–	–	–	–	–	–
236	SCB $9/12_1$IV	12	6	27	27	260	110	20	45	230	20	230	45	+/	–
237	SCB $12/7_1$IV	12	6	27	27	260	110	20	45	230	20	230	45	+/	
238	SCB $2/4_4$IV	0	30	-1.5	2	24000	24000	320	320	–	–	–	–	–	–
239	SCB $2/28_3$IV	1	35	11	8.5	460	460	330	330	–	–	–	–	–	–
240	SCB $2/28_6$IV	0	45	20	11	–	–	–	–	–	–	–	–	–	–
241	SCB $4/15_1$IV	0	5	21	18	400	330	0	330	–	–	–	–	–	–
242	SCB $5/13_3$IV	0	–	26	19	2200	2200	110	110	–	–	–	–	–	–
243	SCB $6/30_2$IV	0	45	35	21	5400	2200	230	700	–	–	–	–	–	–
244	SCB $7/24_1$IV	0	70	28	24	2800	950	330	230	410	–	–	–	–	–
245	SCB $8/20_4$IV	0	210	22	22	24000	24000	580	140	2400	2400	–	–	–	5.4
246	SCB $9/12_2$IV	1	12	30	21	9200	3500	330	460	2400	110	330	330	0	–
247	SCB $9/25_4$IV	0	–	27	13.5	2400	2400	2400	2400	0	–	3500	1300	0	7
248	SCB $10/12_1$IV	Q	–	16	24	1200	1200	330	950	18	0	3000	470	0	–
249	SCB $10/31_1$IV	1	100	21	16	3500	240	230	240	0	0	3500	3500	0	–
250	SCB $11/15_3$IV	0	28	15	10	3500	1300	1300	1300	78	20	2400	220	0	–

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
251	SCB $2/28_7$IV	-	-	15	-	2400	130	45	78	-	-	-	-	-	-
252	SCB $2/28_{10}$IV	6	45	14	16	230	130	45	130	-	-	-	-	-	-
253	SCB $3/28_2$IV	4	-	17	12.5	170	170	18	130	-	-	-	-	-	-
254	SCB $2/4_3$IV	0	48	-2	3	24000	810	190	320	-	-	-	-	-	-
255	SCB $2/28_2$IV	0	60	11	8	110	20	20	20	-	-	-	-	-	-
256	SCB $2/28_5$IV	0	55	20	11	230	0	0	0	-	-	-	-	-	-
257	SCB $4/15_2$IV	0	5	25	18	1100	1100	0	45	-	-	-	-	-	-
258	SCB $5/13_3$IV	0	-	26	19	2200	2200	110	110	-	-	-	-	-	-
259	SCB $6/30_1$IV	0	55	30	19	640	260	330	170	-	-	-	-	-	-
260	SCB $7/24_2$IV	0	-	27	25	2200	1700	490	170	-	-	-	-	-	-
261	SCB $8/20_3$IV	0	100	22	22	16000	5400	230	400	18	18	-	-	-	5.4
262	SCB $9/12_3$IV	1	10	29	21	3500	1300	78	110	1300	130	700	490	0	-
263	SCB $9/25_3$IV	0	-	27	16	330	330	230	230	0	0	460	210	0	7.8
264	SCB $10/12_2$IV	0	-	25	16	700	700	140	460	0	0	170	130	0	-
265	SCB $10/31_2$IV	1	90	21	17	790	790	170	790	0	0	790	790	0	-
266	SCB $11/15_2$IV	0	27	14	11	2400	1300	68	140	0	0	330	110	0	-
267	SCB $2/4_2$IV	0	79	-2	3	24000	810	260	320	-	-	-	-	-	-
268	SCB $2/28_1$IV	0	35	11	9	20	20	20	20	-	-	-	-	-	-
269	SCB $2/28_4$IV	0	30	23	9	45	0	0	0	-	-	-	-	-	-
270	SCB $4/15_3$IV	0	2	23	19	9200	2800	0	110	-	-	-	-	-	-
271	SCB $8/20_2$IV	0	115	23	22	24000	24000	230	81	68	68	-	-	-	4
272	SCB $9/12_4$IV	1	9	31	21	3500	1700	140	170	2100	45	1800	170	0	-
273	SCB $9/25_2$IV	0	-	28	16	330	330	45	110	0	0	330	170	0	7.2
274	SCB $10/12_3$IV	0	-	24	16.5	490	330	230	170	0	0	120	61	2	-
275	SCB $10/31_3$IV	0	30	22	16	230	230	78	130	0	0	330	330	0	-
276	SCB $11/15_1$IV	1	18	16	11	3500	790	110	170	0	0	130	130	0	-
277	SCB $2/4_1$IV	0	92	-2	1.5	810	810	210	320	-	-	-	-	-	-
278	SCB $4/15_4$IV	0	10	22	14	9200	5400	0	280	-	-	-	-	-	-
279	SCB $8/20_1$IV	0	80	23	22	24000	16000	230	68	68	68	-	-	-	5.0
280	SCB $9/25_1$IV	2	-	26.5	18	330	230	20	78	0	0	230	0	0	7.5

APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
J 281	SCB 3/28$_{3}$III	19	-	17	12	18	18	0	0	-	-	-	-	-	-
282	SCB 3/28$_{6}$III	23	-	19	11.8	78	78	20	78	-	-	-	-	-	-
283	SCB 4/29$_{3}$III	21	10	26	22	170	18	18	0	-	-	-	-	-	-
284	SCB 9/12$_{4}$III	13	8	28	26	280	78	0	20	0	0	78	0	+/	-
285	SCB 12/7$_{3}$III	27	10	12	8.5	0	0	0	0	0	0	0	0	0	15
286	SCB 4/29$_{4}$III	25	5	26	22	170	18	18	0	-	-	-	-	-	-
287	SCB 6/30$_{4}$III	17	25	29	26.5	45	20	0	0	-	-	-	-	-	-
288	SCB 9/12$_{5}$III	15	12	27.5	26	0	0	0	0	0	0	78	0	+/	-
289	SCB 3/28$_{4}$III	21.5	-	18	12	0	0	0	0	-	-	-	-	-	-
290	SCB 3/28$_{5}$III	24	-	18	12.5	310	310	0	170	-	-	-	-	-	-
291	SCB 6/30$_{5}$III	20	20	24	26	130	20	0	0	-	-	-	-	-	-
292	SCB 9/12$_{6}$III	17	7	27	26	78	0	0	0	0	0	45	0	+/+	-
293	SCB 12/7$_{2}$III	28	10	12	8.5	1400	950	0	700	0	0	0	0	0	7.7
M 294	SCB 2/28$_{1}$III	18	15	15	-	0	0	0	0	-	-	-	-	-	-
295	SCB 2/28 III	25	10	15	-	20	20	20	20	-	-	-	-	-	-
296	SCB 3/28$_{1}$III	21	-	13	12.5	78	78	0	78	-	-	-	-	-	-
297	SCB 4/29$_{5}$III	28	5	17	22	130	0	0	0	-	-	-	-	-	-
298	SCB 9/12$_{7}$III	16	7	27	26	37	37	0	18	20	0	310	18	+/	-
299	SCB 11/7$_{1}$III	30	8	14	9	0	0	0	0	0	0	0	0	/	7.5
L 300	SCB 1/17$_{1}$III	2	-	2	2	270	40	0	18	-	-	-	-	-	-
301	SCB 1/21$_{1}$III	0	55	10	10	3500	1100	120	61	-	-	-	-	-	-
302	SCB 2/28$_{7}$III	0	20	22	10	-	-	-	-	-	-	-	-	-	-
303	SCB 4/29$_{6}$III	0	10	25	20	790	330	0	20	-	-	-	-	-	-
304	SCB 5/27$_{1}$III	1	70	23	20	1700	490	110	140	-	-	-	-	-	-
305	SCB 7/24$_{2}$III	0	50	30	27	1500	950	330	210	-	-	-	-	-	-
306	SCB 10/12$_{1}$III	1	-	25	15	330	230	45	45	40	0	82	18	-	-
307	SCB 11/15$_{1}$III	0	42	17	10	61	18	0	0	0	0	130	20	-	-
308	SCB 1/17$_{7}$ V	5	-	2	2	490	490	490	490	-	-	-	-	-	-
309	SCB 1/21$_{1}$ V	2	50	9	9	2200	790	790	790	-	-	-	-	-	-
310	SCB 4/29$_{1}$ V	14	5	27	25	790	330	330	170	-	-	-	-	-	-

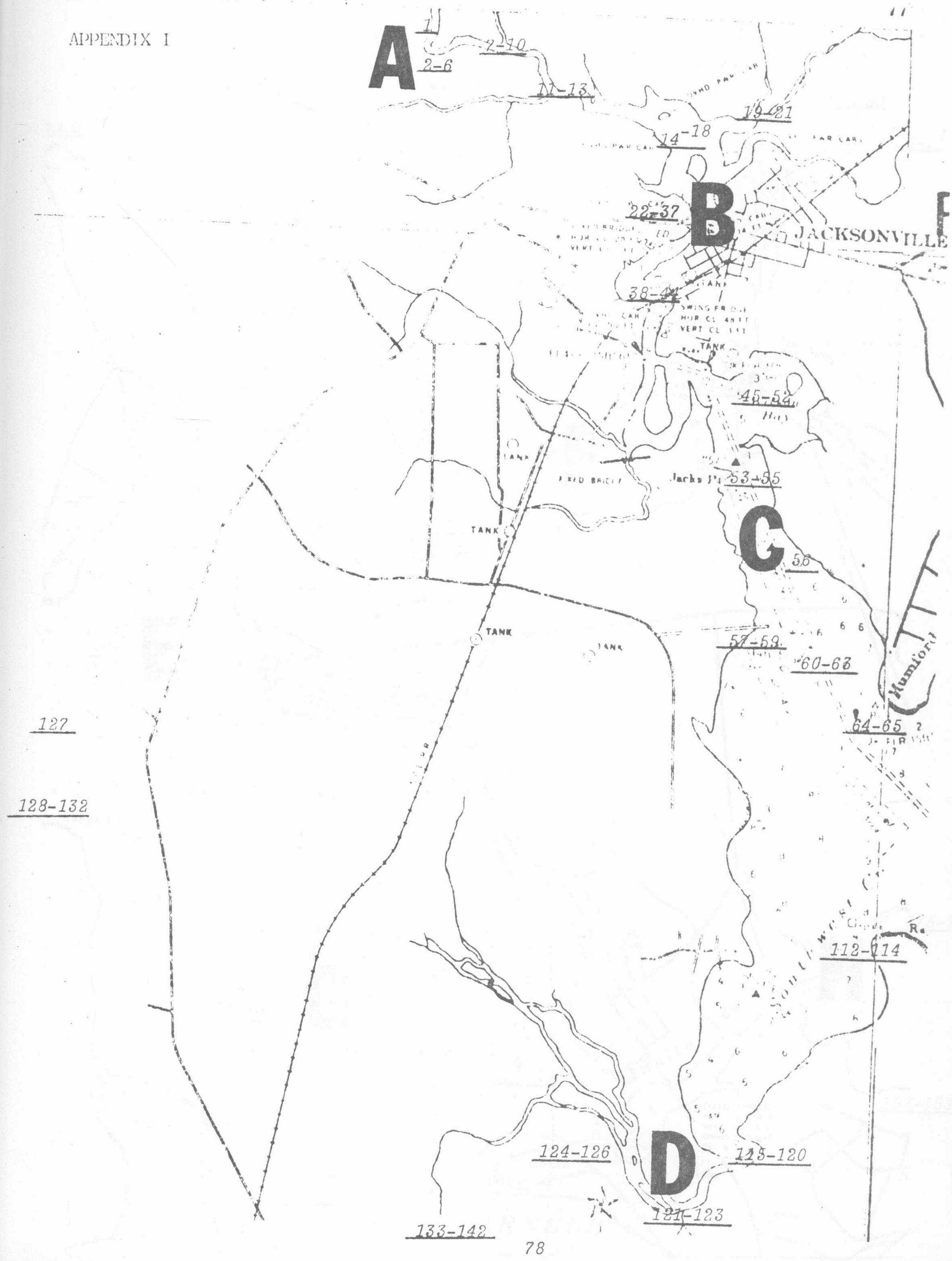
APPENDIX I

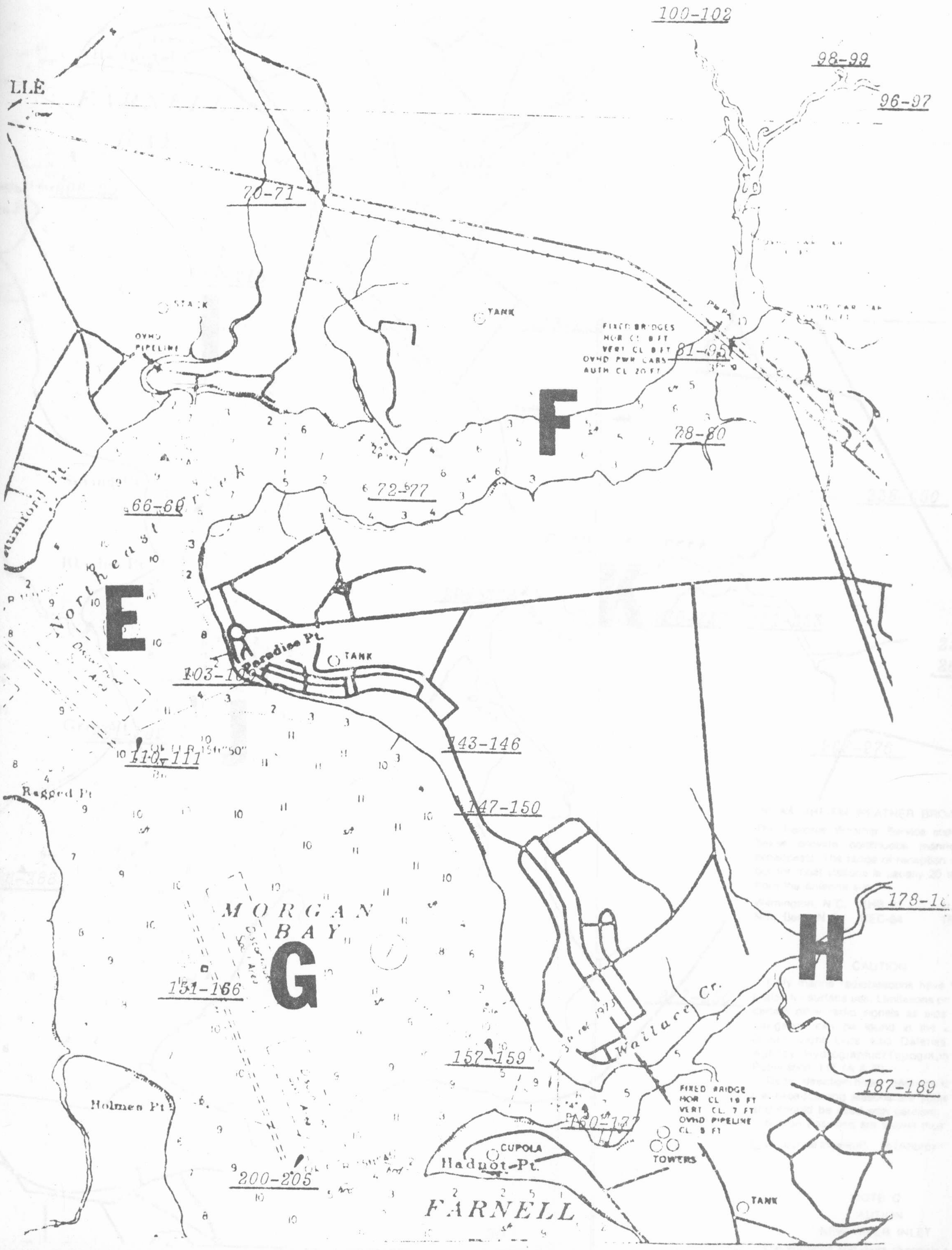
#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
311	SCB $5/27_{4}^{V}$	2	90	23	23	790	790	330	220	-	-	-	-	-	-
312	SCB $6/30_{3}^{V}$	13	40	26	26	24000	9200	110	110	-	-	-	-	-	-
313	SCB $7/24_{1}^{V}$	11	45	29	28	9200	5400	130	0	490					
314	SCB $8/20_{1}^{V}$	0	145	23	21	24000	24000	230	240	20	20	-	-	-	-
315	SCB $10/12_{3}^{V}$	15	-	27	18	9200	9200	460	9200	18	0	440	170	-	-
316	SCB $11/15_{1}^{V}$	22	29	17	12	24000	5400	490	2200	330	45	490	330	-	-
317	SCB $1/17_{11}^{V}$	0	-	2	2	330	130	0	20	-	-	-	-	-	-
318	SCB $1/21_{2}^{V}$	1	65	9	8	1100	460	45	110	-	-	-	-	-	-
319	SCB $5/27_{5}^{V}$	1	80	23	19	330	330	20	20	-	-	-	-	-	-
320	SCB $7/24_{2}^{V}$	1	95	28	29	1700	1700	0	82	-	-	-	-	-	-
321	SCB $10/12_{4}^{V}$	0	-	25	16	3500	2400	78	270	230	130	20	0	-	-
322	SCB $11/15_{2}^{V}$	0	73	18	12	1800	460	0	210	0	0	490	0	-	-
323	SCB $1/17_{9}^{V}$	0	-	2	2	110	20	0	0	-	-	-	-	-	-
324	SCB $1/21_{4}^{V}$	0	65	9	9	130	130	45	20	-	-	-	-	-	-
325	SCB $7/24_{3}^{V}$	0	90	30	29	2200	470	20	20	-	-	-	-	-	-
326	SCB $1/17_{8}^{V}$	0	-	2	2	270	220	45	93	-	-	-	-	-	-
327	SCB $1/21_{5}^{V}$	0	45	9	9	230	230	130	45	-	-	-	-	-	-
328	SCB $5/27_{3}^{V}$	1	70	24.5	20	700	330	110	170	-	-	-	-	-	-
329	SCB $7/24_{4}^{V}$	0	55	30	29	5400	3500	20	130	-	-	-	-	-	-
M 330	SCB $1/17_{10}^{V}$	14	-	2	2	1100	180	0	180	-	-	-	-	-	-
331	SCB $1/21_{8}^{V}$	9	30	9	9	3500	790	130	220	-	-	-	-	-	-
332	SCB $5/27_{6}^{V}$	21	40	24	23	490	490	40	330	-	-	-	-	-	-
333	SCB $3/28_{2}^{V}$	24.5	-	16	12	310	310	0	170	-	-	-	-	-	-
334	SCB $6/30_{2}^{V}$	21	20	26	26	78	20	0	0	-	-	-	-	-	-
335	SCB $9/12_{2}^{V}$	16	8	29	26	20	20	0	0	0	0	20	0	+/	-
336	SCB $1/17_{2}^{V}$	21	-	2	2	790	270	0	110	-	-	-	-	-	-
337	SCB $1/17_{3}^{V}$	19	-	2	2	45	45	20	20	-	-	-	-	-	-
338	SCB $5/27_{2}^{V}$	28	90	24	24	45	20	0	20	-	-	-	-	-	-
339	SCB $6/30_{1}^{V}$	14	30	28	26	130	0	0	0	-	-	-	-	-	-
340	SCB $9/12_{1}^{V}$	16	5	28.5	26	55	55	0	0	0	0	20	0	0	-

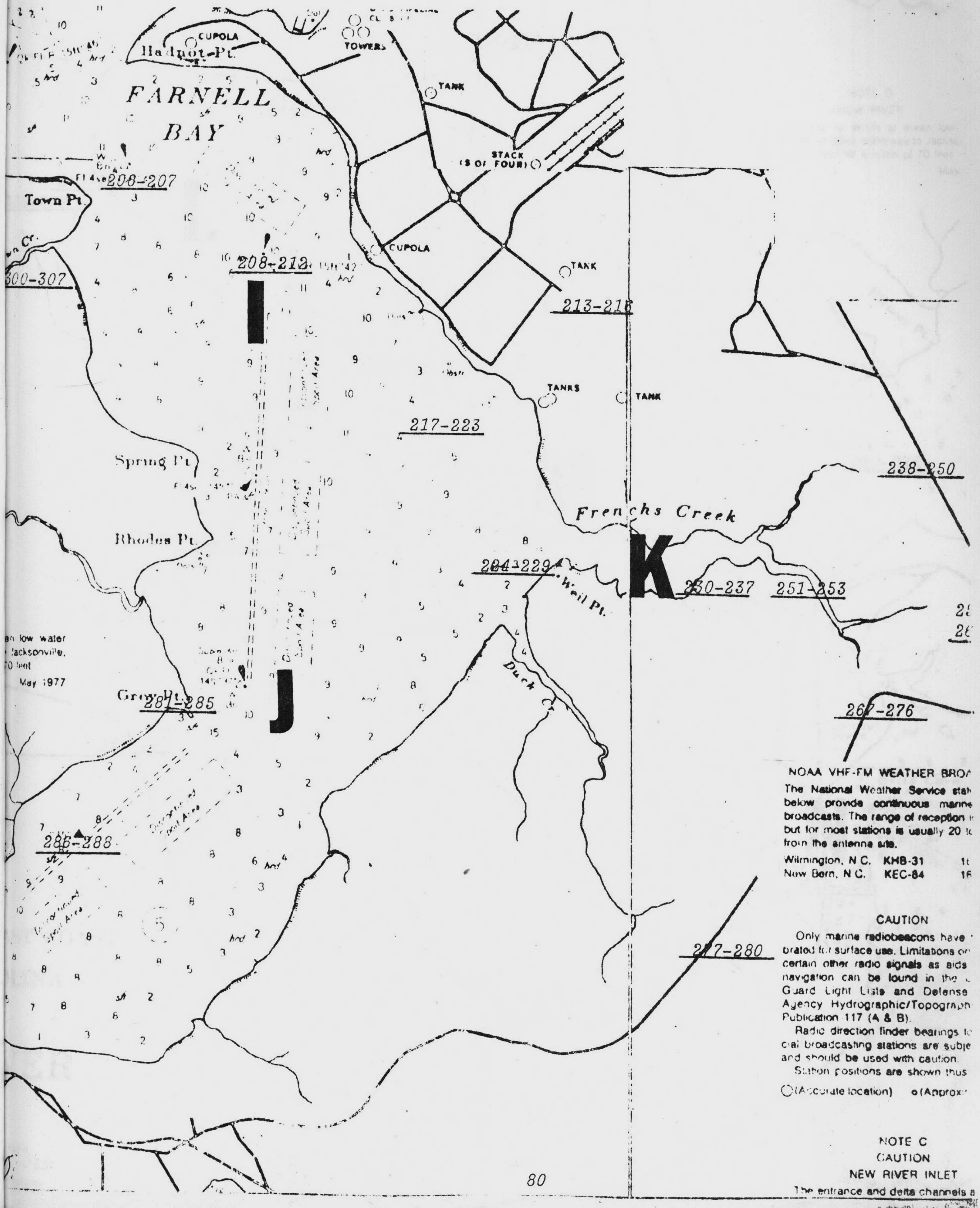
APPENDIX I

#	Sta	S	Tur	At	Wt	Lt	BGB	EC	EMB	Asp	Act	AZD	EVA	Vib	D.O
L 341	SCB 1/17$_{1}$V	0	-	-2	0	490	330	220	330	-	-	-	-	-	-
342	SCB 2/28$_{2}$V	0	40	21	13	330	330	330	45	-	-	-	-	-	-
343	SCB 5/27$_{1}$V	8	80	24	25	3500	1700	330	130	-	-	-	-	-	-
344	SCB 7/24$_{6}$V	5	70	30	28	2400	1300	1300	0	230	-	-	-	-	-
345	SCB 10/12$_{2}$V	19	-	27	19.5	3500	3500	1300	3500	0	-	5400	3300	-	-
346	SCB 10/31$_{2}$V	10	175	18	17.5	700	700	230	700	20	20	1300	230	91/1	-
347	SCB 1/17$_{4}$V	-	-	2.5	.8	400	210	120	82	-	-	-	-	-	-
348	SCB 1/21$_{6}$V	0	55	12	7	3500	1700	700	1400	-	-	-	-	-	-
349	SCB 4/29$_{2}$V	2	1	27	20.5	1300	1300	45	45	-	-	-	-	-	-
350	SCB 5/27$_{8}$V	1	70	24.5	20	700	330	110	170	-	-	-	-	-	-
351	SCB 6/30$_{4}$V	0	120	26	19	16000	540	140	240	-	-	-	-	-	-
352	SCB 7/24$_{5}$V	0	105	30	27	1800	1800	0	61	-	-	-	-	-	-
353	SCB 10/12$_{1}$V	1	-	27	15	9200	1700	490	1700	110	0	490	140	5/	-
354	SCB 10/31$_{1}$V	0	55	19	14	2800	2800	2800	2800	0	0	16000	16000	0	-
355	SCB 11/15$_{3}$V	5	57	17	11	24000	2800	490	3500	120	20	3500	3500	0	-
356	SCB 1/17$_{1}$VII	23	18	-2.8	.2	0	0	0	0	-	-	-	-	-	-
357	SCB 3/28$_{1}$VII	23.5	-	18	12.5	0	0	0	0	-	-	-	-	-	-
358	SCB 4/29$_{1}$VII	29	1	27	22	230	0	0	0	-	-	-	-	-	-
359	SCB 6/30$_{1}$VII	20	30	28	-	330	20	0	0	-	-	-	-	-	-
360	SCB 8/20$_{1}$VII	16	190	24	22	24000	24000	310	55	24000	3500	-	-	-	6.6
361	SCB 9/25$_{1}$VII	22	-	27	21	20	0	0	0	0	0	230	0	.57/1	-
362	SCB 10/12$_{1}$VII	24	-	25	17.5	490	330	0	68	0	0	91	45	157/5	7.5
363	SCB 10/31$_{1}$VII	38	40	22	17	130	0	0	0	0	0	230	20	106/2	-
364	SCB 11/15$_{1}$VII	30	13	15	10	790	330	45	110	0	0	20	0	47/	-
365	SCB 12/7$_{1}$VII	31	10	14	8.5	0	0	0	0	0	0	0	0	0	7.0
366	SCB 9/12$_{1}$VII	20	2	27.5	25.5	20	0	0	0	0	0	230	0	+/	-

APPENDIX I


A
B
C
D
JACKSONVILLE
1
2-10
2-6
11-13
14-18
19-21
22-37
38-44
45-52
53-55
56
57-59
60-63
64-65
112-114
115-120
121-123
124-126
127
128-132
133-142
TANK
FIXED BRIDGE
Humford


100-102
98-99
96-97
LLE
70-71
STACK
TANK
OVHD PIPELINE
FIXED BRIDGES
81-85
78-80
F
72-77
66-69
Northeast Creek
E
Paradise Pt.
TANK
103-109
110-111
Ragged Pt.
143-146
147-150
MORGAN BAY
G
151-166
H
178-18
Wallace Cr.
157-159
187-189
FIXED BRIDGE
HOR. CL. 18 FT
VERT. CL. 7 FT
OVHD PIPELINE
CL. 5 FT
Holmes Pt.
CUPOLA
TOWERS
Hadnot Pt.
200-205
FARNELL
TANK



NOAA VHF-FM WEATHER BROA

The National Weather Service stat below provide continuous marine broadcasts. The range of reception i but for most stations is usually 20 t from the antenna site.

Wilmington, N.C. KHB-31 1
New Bern, N.C. KEC-84 16

CAUTION

Only marine radiobeacons have brated for surface use. Limitations or certain other radio signals as aids navigation can be found in the Guard Light Lists and Defense Agency Hydrographic/Topograph Publication 117 (A & B).

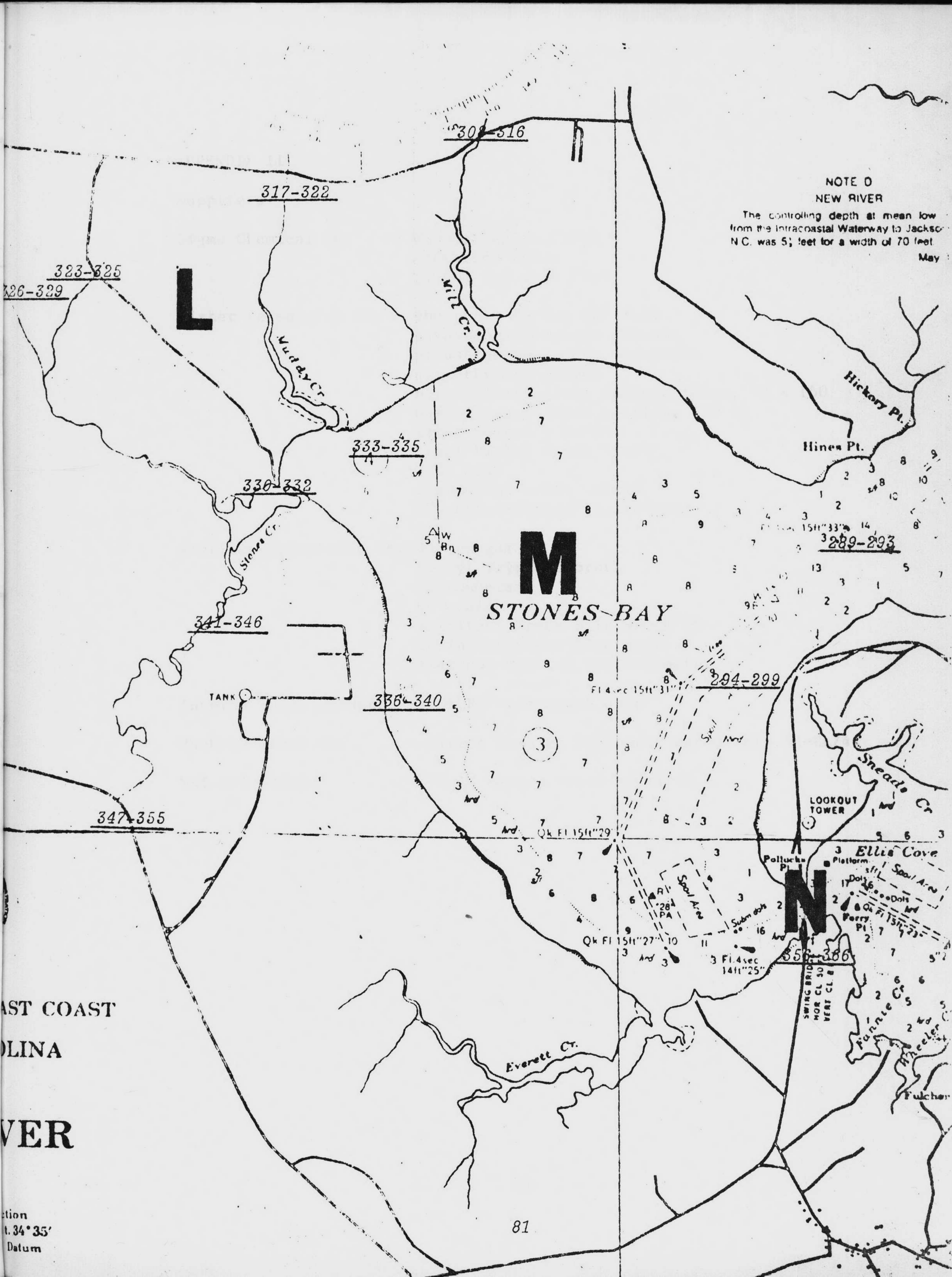
Radio direction finder bearings to cial broadcasting stations are subje and should be used with caution.

Station positions are shown thus

◯ (Accurate location) o (Approx

NOTE C
CAUTION
NEW RIVER INLET

The entrance and delta channels a



308-316
317-322
323-325
326-329
L
Muddy Cr.
Mill Cr.
333-335
330-332
Stones Cr.
M
STONES BAY
341-346
TANK
336-340
347-355
NOTE D
NEW RIVER
The controlling depth at mean low from the Intracoastal Waterway to Jackso N.C. was 5½ feet for a width of 70 feet.
May
Hickory Pt.
Hines Pt.
289-293
294-299
Fl 4sec 15ft"31"
Spoil Area
Sneads Cr.
LOOKOUT TOWER
Qk Fl 15ft"29"
Ellis Cove
Pollocks Pt.
Platform
Spoil Area
N
Ferry Pt.
Subm dols
Qk Fl 15ft"27"
3 Fl 4sec 14ft"25"
356-366
SWING BRIDGE HOR CL 50 VERT CL 8
Fannie Cr.
Wheeler Cr.
Fulcher
Everett Cr.
AST COAST
OLINA
VER
ction
t. 34° 35′
Datum

APPENDIX II

Suppliers

Sigma Chemical Co.	- DL-asparagine (pfs) acetamide (pfs) phenol red acid free
Fisher Scientific Co.	- phosphate buffer (pH 7.2) potassium phosphate dibasic potassium phosphate monobasic polyethylene gloves borosilicate glass culture tubes, 18 X 150 borosilicate glass bottles, 250 ml Azide Dextrose Broth Ethyl Violet Azide Broth TCBS agar microscope slide labels 6" cotton-tipped applicators
American Scientific Co.	-Bacto-agar Lauryl Tryptose broth thermometers EC media Brilliant Green Bile Broth 2% Eosin Methylene Blue agar American Optical refractometer
International Products	- "MICRO" glassware soap
Hach Chemical Co.	- Direct Reading Engineers Laboartory DR-EL/4
YSI Scientific	- field oxygen meter model 57

APPENDIX III - SALINITY, TURBIDITY AND WATER TEMPERATURE GRAPHS AT SIX STATIONS OF THE NEW RIVER ESTUARY

FIGURE 13 - SALINITY, TURBIDITY AND WATER TEMPERATURE AT STATION 1 FROM NOVEMBER 1980 - 1981 NEW RIVER ESTUARY

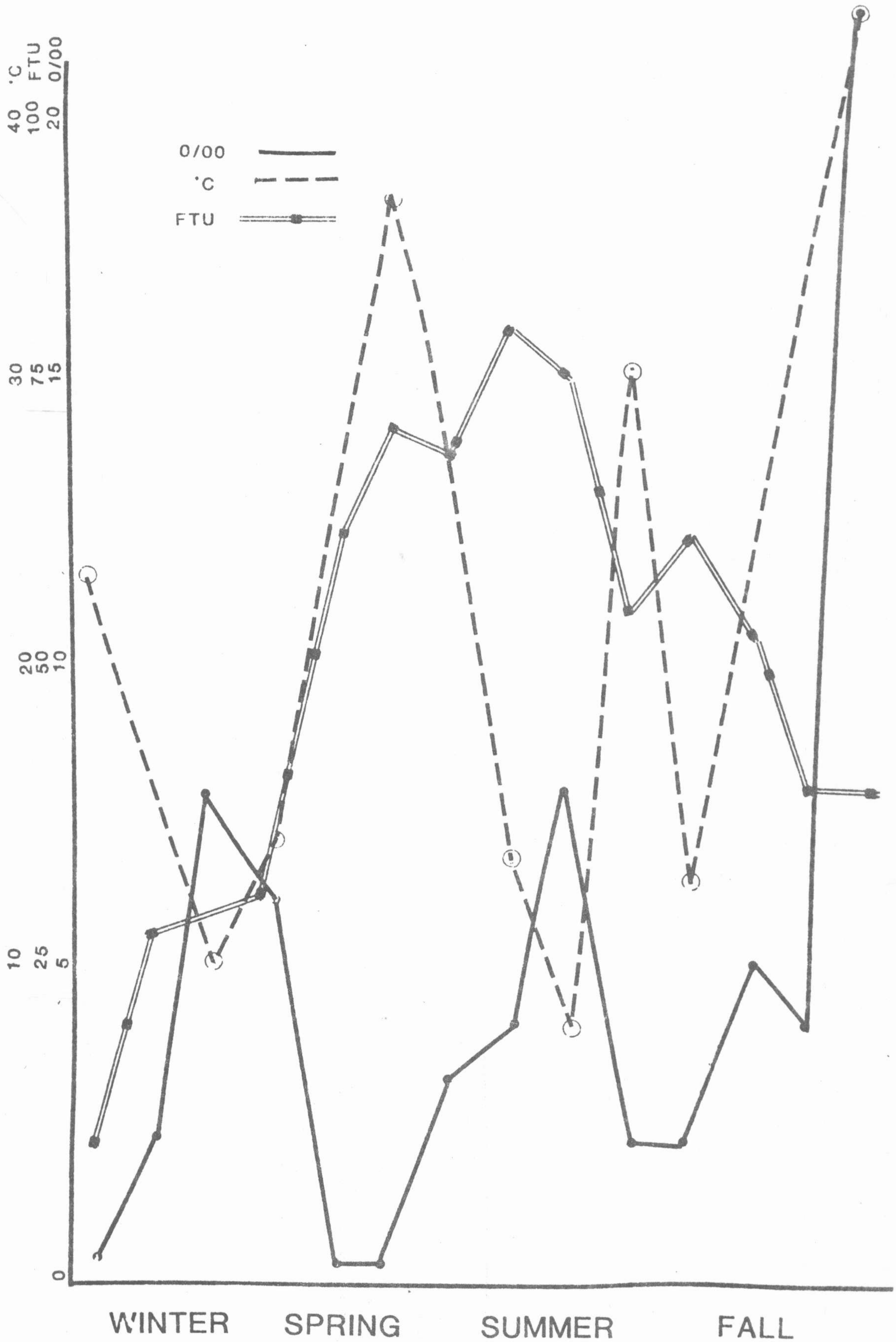
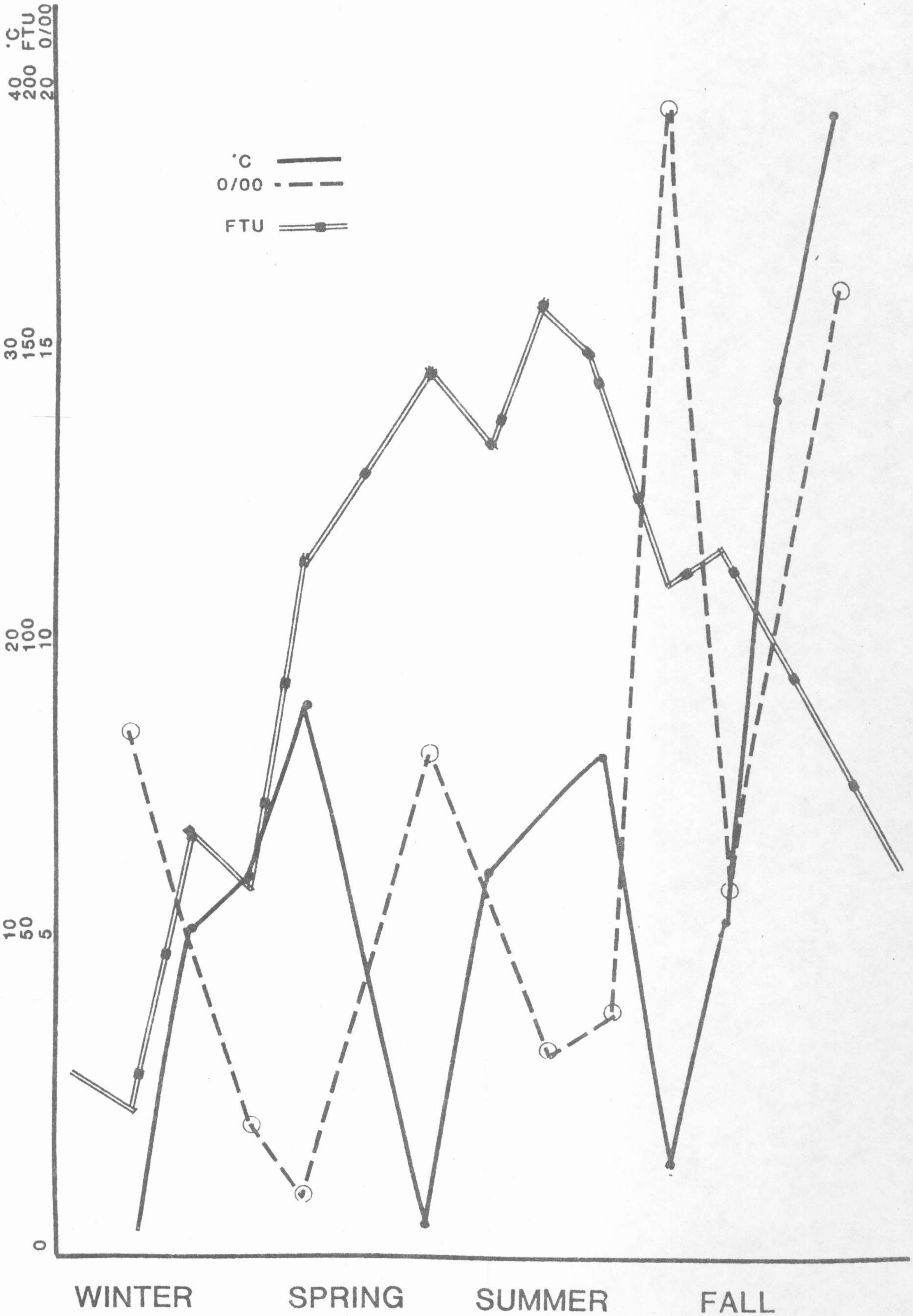

40 100 20
°C FTU 0/00
30 75 15
20 50 10
10 25 5
0
0/00
°C
FTU
WINTER
SPRING
SUMMER
FALL

FIGURE 14 - SALINITY, TURBIDITY AND WATER TEMPERATURE AT STATION 2 FROM NOVEMBER 1980 - 1981 NEW RIVER ESTUARY



40 200 20
'C FTU 0/00
30 150 15
20 100 10
10 50 5
0
'C
0/00
FTU
WINTER
SPRING
SUMMER
FALL

FIGURE 15 - SALINITY, TURBIDITY AND WATER TEMPERATURE AT STATION 3 FROM NOVEMBER 1980 - 1981 NEW RIVER ESTUARY

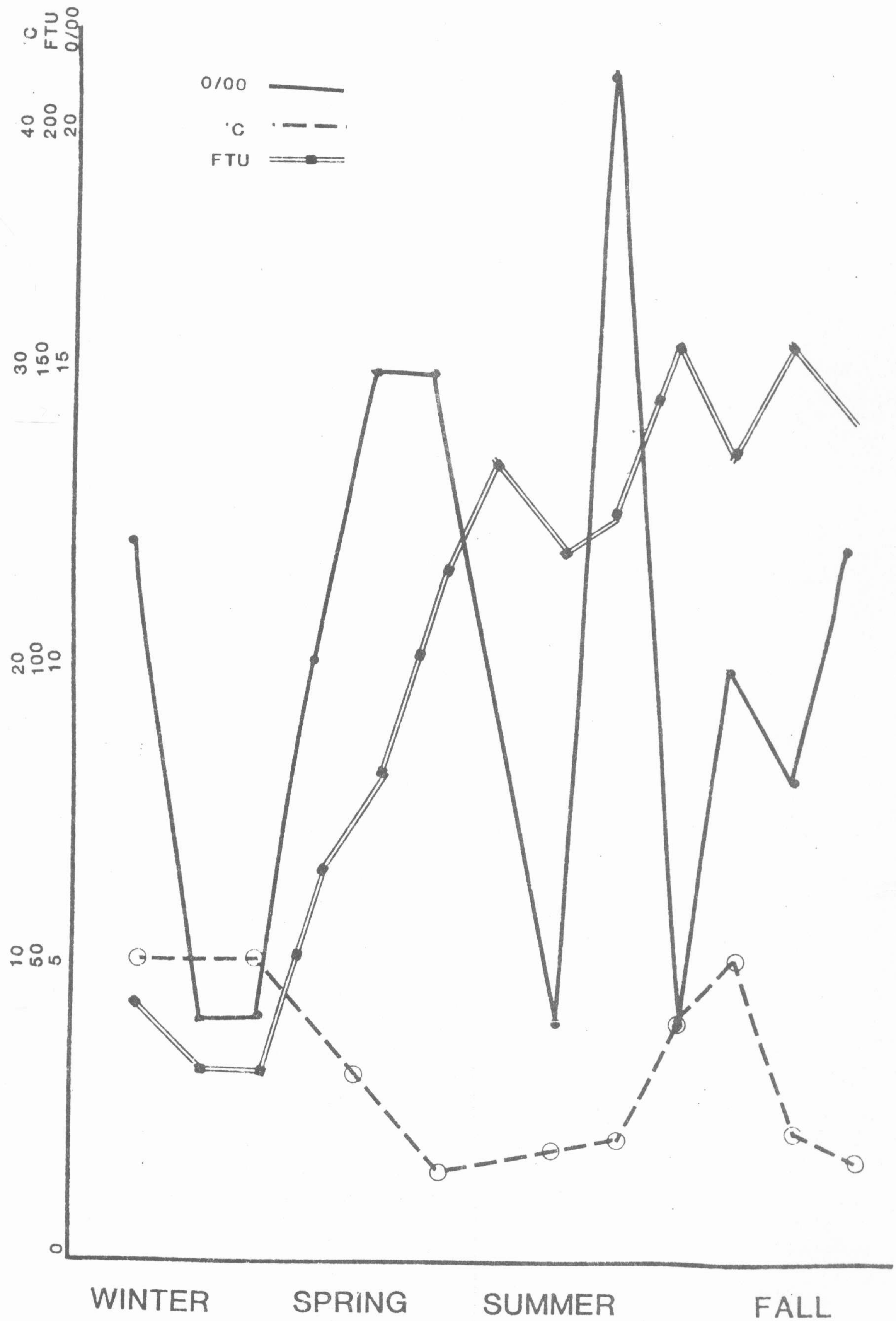

'C
FTU
0/00
0/00
'C
FTU
40
200
20
30
150
15
20
100
10
10
50
5
0
WINTER
SPRING
SUMMER
FALL

FIGURE 16 - SALINITY, TURBIDITY AND WATER TEMPERATURE AT STATION 4 FROM NOVEMBER 1980 - 1981 NEW RIVER ESTUARY

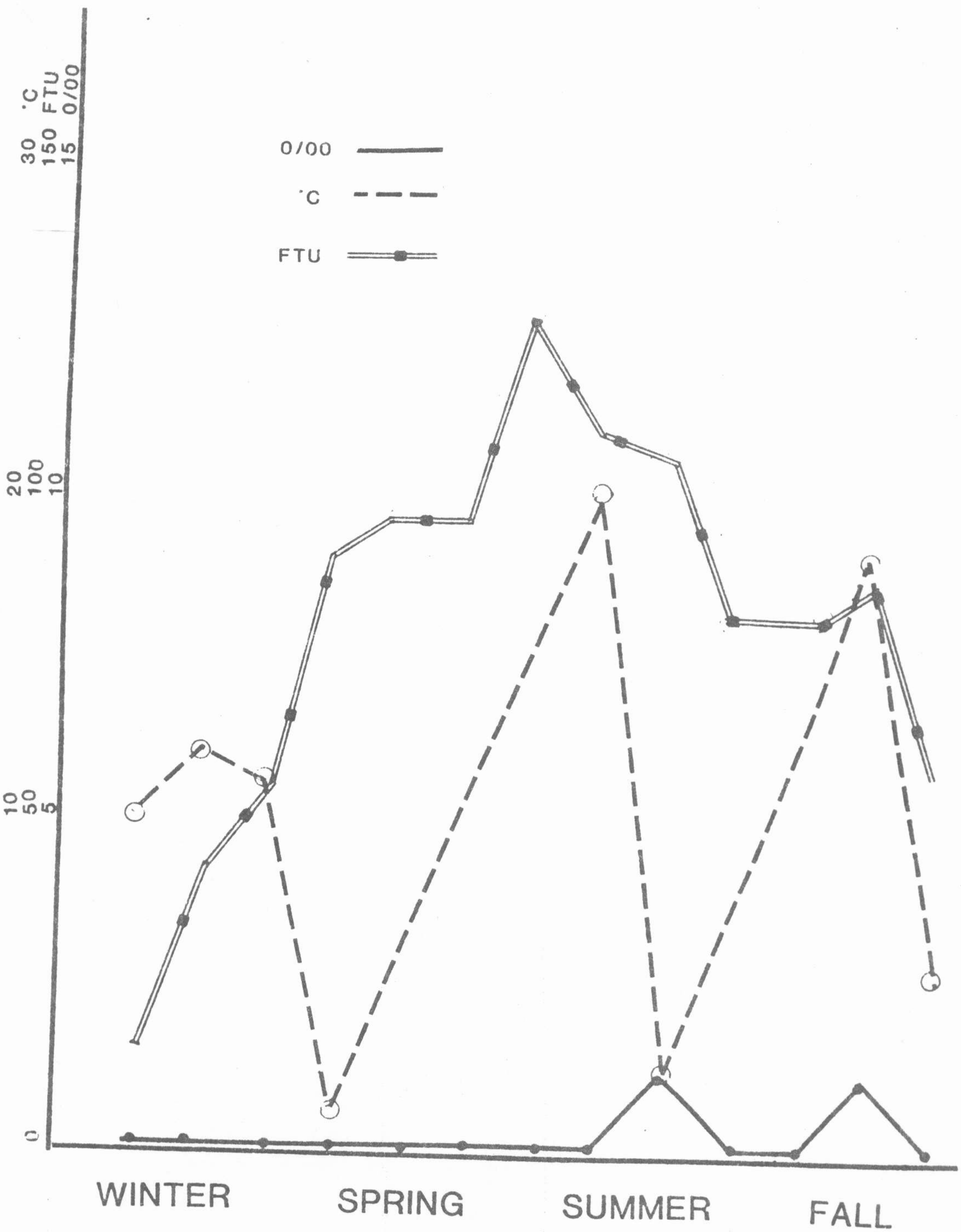

30 150 15
°C FTU 0/00
20 100 10
10 50 5
0
0/00
°C
FTU
WINTER
SPRING
SUMMER
FALL

FIGURE 17 - SALINITY, TURBIDITY AND WATER TEMPERATURE AT STATION 6 FROM NOVEMBER 1980 - 1981 NEW RIVER ESTUARY

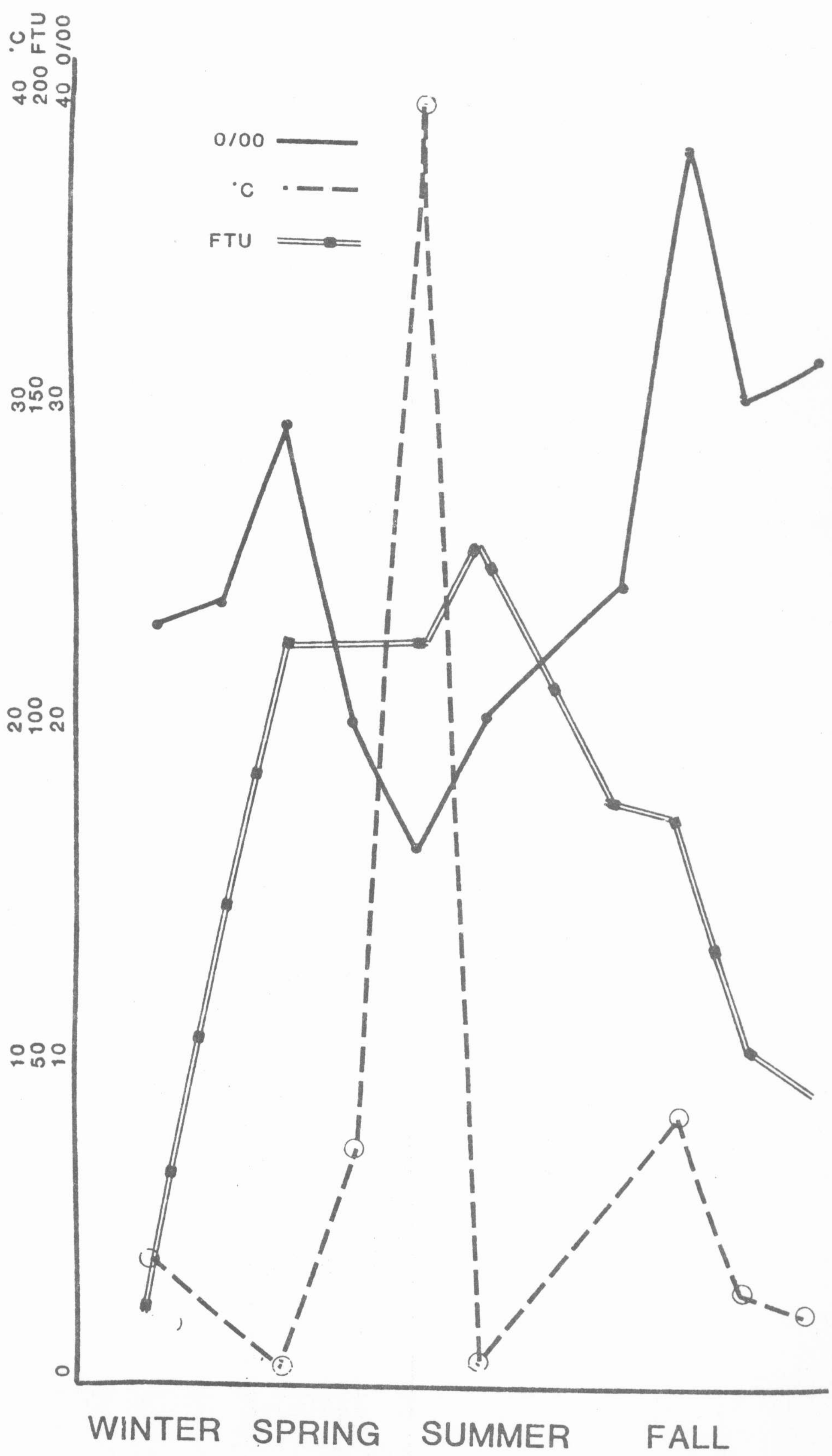
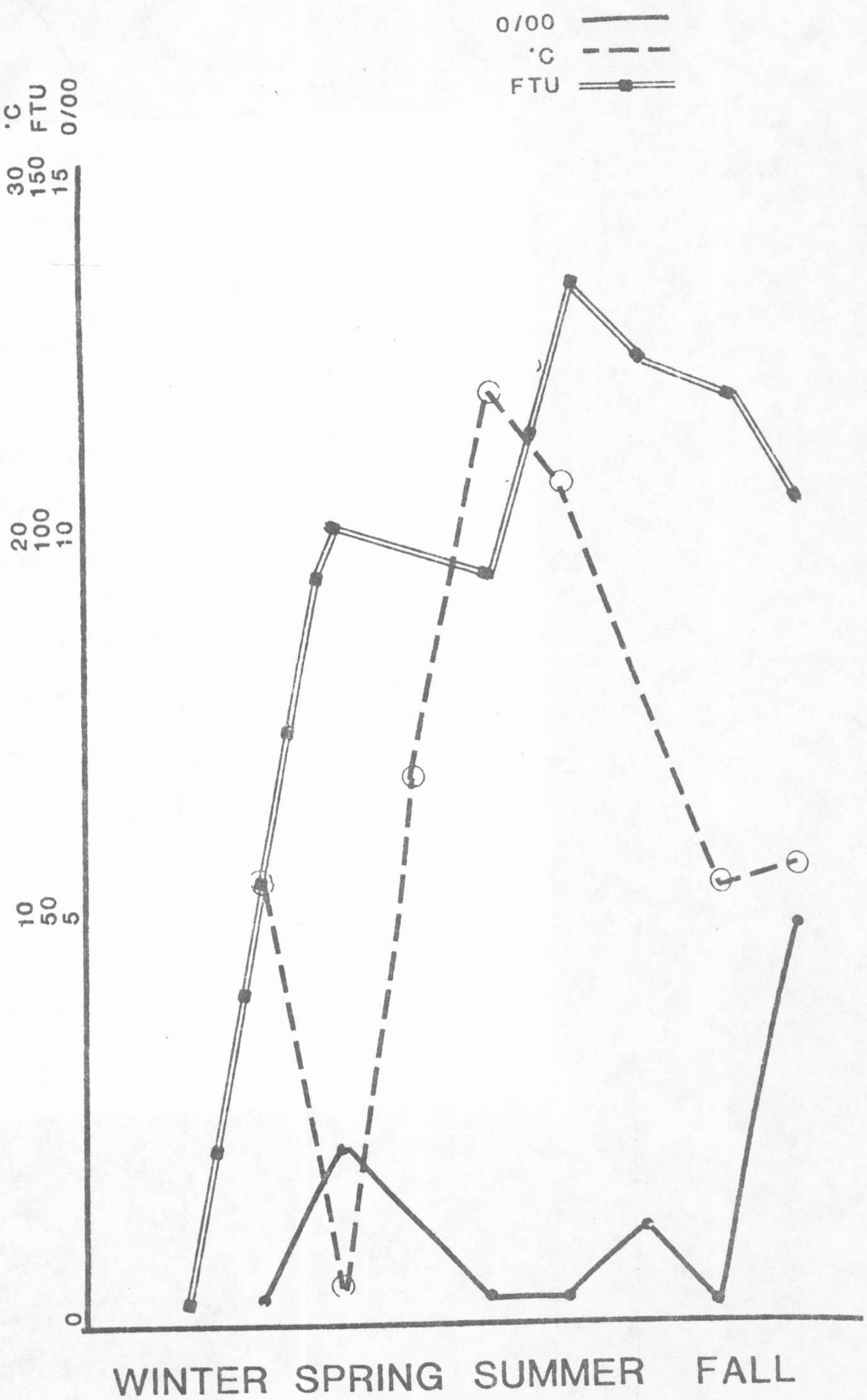

40 °C
200 FTU
40 0/00
30
150
30
20
100
20
10
50
10
0
0/00
°C
FTU
WINTER
SPRING
SUMMER
FALL

FIGURE 18 - SALINITY, TURBIDITY AND WATER TEMPERATURE AT STATION 7 FROM NOVEMBER 1980 - 1981 NEW RIVER ESTUARY


0/00
°C
FTU
30 150 15
20 100 10
10 50 5
0
°C FTU 0/00
WINTER SPRING SUMMER FALL

QUERIED

plants

- type
- location
- gpd
- monitoring - how, operators
- reports
- landfill open
  - size
  - closure

state-certified operators

stormwater

- base population
- areas closed to swimming
- base marina (Gottsschalk), near stables (20,000 people)
- animal runoff — showers after operators
- ~~buffer zones and outfalls~~
- ~~trickling filters~~
- field exercises
- forested areas burned
- l.f. stks failures

---

report – single plant monitoring

most recent plant trtmt method

BAIN – get MC info

Hadnot 4.7M gpd into NR French

Rifle Range 235K gpd into NR Evertt

University of North Carolina

at Wilmington

28406

APPENDIX 4 - NEW RIVER STUDY QUESTIONNAIRE

A study of the New River estuary has been conducted by the University of North Carolina at Wilmington over the past two years. One of the project goals is to increase fishing and other recreational usage of the estuary. However, we need to ascertain the present level of such usage, information that can be supplied by such users as yourself. We would greatly appreciate your taking a few minutes to complete the enclosed questionnaire. Because responses will be computerized, individual replies will not be identified. Personal comments are welcome in addition to the survey questions.

For your convenience, a stamped return envelope is enclosed. Thank you for your participation.

Sincerely,

G. Bane

Gilbert W. Bane, Ph.D.
Director, Environmental Studies
Principal Investigator

University of North Carolina

[illegible]

[illegible] of the [illegible] by the
University of North Carolina [illegible] over the next two
years. [illegible] of the present [illegible]
[illegible] usage [illegible]
[illegible] present level. [illegible]
can be [illegible] by [illegible]
[illegible] taking a few [illegible]
[illegible] because [illegible]
[illegible] will [illegible]

[illegible]
[illegible] your participation [illegible]

[illegible]

[illegible]
[illegible]
[illegible]

13. Approximately how many pounds did your total catch weigh during the past 12 months?

( ) 0-100
( ) 100-500
( ) 500-1000
( ) 1000-5000
( ) 500-10,000
( ) 10,000-20,000
( ) 20,000-50,000
( ) more than 50,000

14. Is your fishing activity for a particular species? ( )yes ( )no

15. What type of fishing gear and method do you usually use? (Check all that apply)

gear
( )pole and line
( )gill net
( ) seine
( ) cast net (bait)
( ) rake, tong
( ) gig
( ) dredge
( ) other ____________

method
( ) trawling
( ) still fishing
( ) drifting
( ) casting
( )other ____________

16. If you knew in advance that you wouldn't have caught anything in the bay area today, how much money would you have spent on some other activity in Onslow County?

( ) $0-10
( ) $10-$50
( ) $50-$100
( )$100-$300
( )$300-$500
( ) more than $500

17. What is your occupation? ( )

18. Would you indicate which catagory most closely corresponds to your income for the past 12 months?

( )less than $5000
( )$5000-$10,000
( )$10,000-$15,000
( )$15,000-$20,000
( )$20,000-$30,000
( )$30,000-$40,000
( )$40,000-$50,000
( ) more than $50,000

19. Comments on improving the use of the New River

ALL ANSWERS WILL BE KEPT CONFIDENTIAL

1. What is the nature of your activity in the New River area? (check all that apply)
   ( ) swimming
   ( ) recreational boating
   ( ) recreational fishing and/or shellfishing
   ( ) commercial fishing and/or shellfishing

2. Approximately how often do you use the New River for your activity?
   ( )/month
   ( )/year

3. Which general area do you usually use for your activity? (Refer to charts and/or maps)
   ( )A ( )B ( )C ( )D ( )E ( ) F ( )G ( )H ( )I ( )J ( )K ( )L
   ( )M ( )N

4. How many years have you fished in this area? ( )years

5. For how many years in the future do you expect to fish in the New River area?
   ( )years

6. If you used a boat on your last trip: Type of boat( )
   Length of boat ( )ft.
   Number in party ( )males ( )females
   How many days spent in area on trip? ( )days
   Is this your own boat? ( )yes ( )no
   Did (will) you stay overnight in this county as a result of this trip?
   ( )yes ( )no
   At a private residence ( )yes ( )no
   Public lodging ( )yes ( )no

7. Approximately what were the total expenses incurred on this trip in Onslow County? ( )0-$50 ( ) $100-$500 ( ) over $1000
   ( )$50-$100 ( ) $500-$1000

8. Where do you usually launch your boat? ( )private ( )public

9. What is the approximate value of your boat and gear?
   ( ) less than $500
   ( ) $500-$1000
   ( ) $1000-$5000
   ( ) $5000-$20,000
   ( ) $20,000-$50,000
   ( ) $50,000-$100,000
   ( ) $100,000-$500,000
   ( ) more than $500,000

10. How much have you spent in the last 12 months on boat expenses and gear?
   ( )less than $100
   ( ) $100-$500
   ( ) $500-$1000
   ( ) $1000-$5000
   ( ) $5000-$20,000
   ( ) $20,000-$50,000
   ( ) more than $50,000

11. If fishing...what percent:
   sport or recreational
   ( ) 0-5
   ( ) 5-10
   ( ) 10-25
   ( ) 25-50
   ( ) 50-75
   ( ) 75-100

   commercial
   ( ) 0-5
   ( ) 5-10
   ( ) 10-25
   ( ) 25-50
   ( ) 50-75
   ( ) 75-100

12. Is your catch sold? ( )yes ( )no

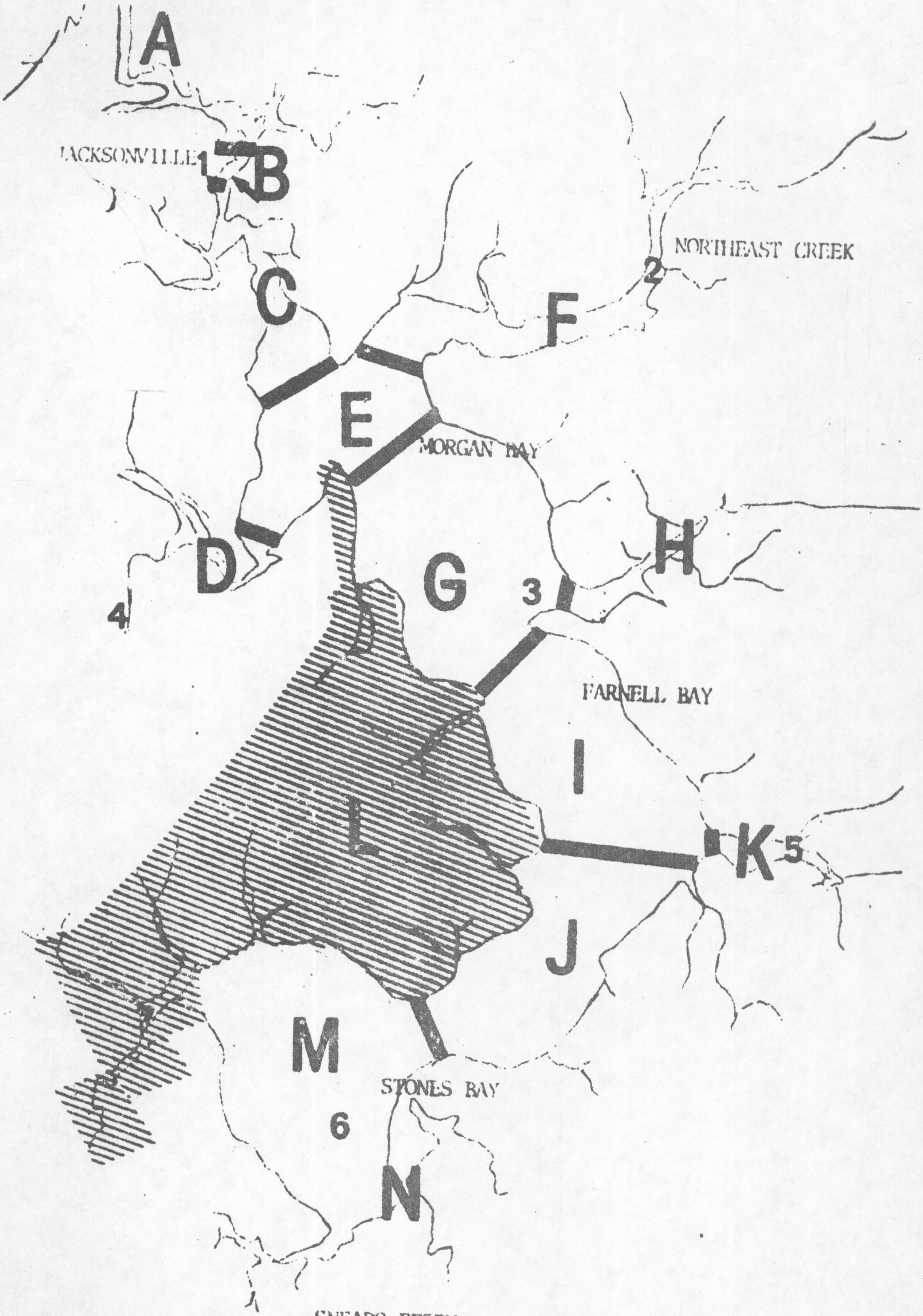

A
JACKSONVILLE
1
B
C
NORTHEAST CREEK
2
F
E
MORGAN BAY
D
4
G
3
H
FARNELL BAY
I
L
K
5
J
M
STONES BAY
6
N
SNEADS FERRY

PLATE I

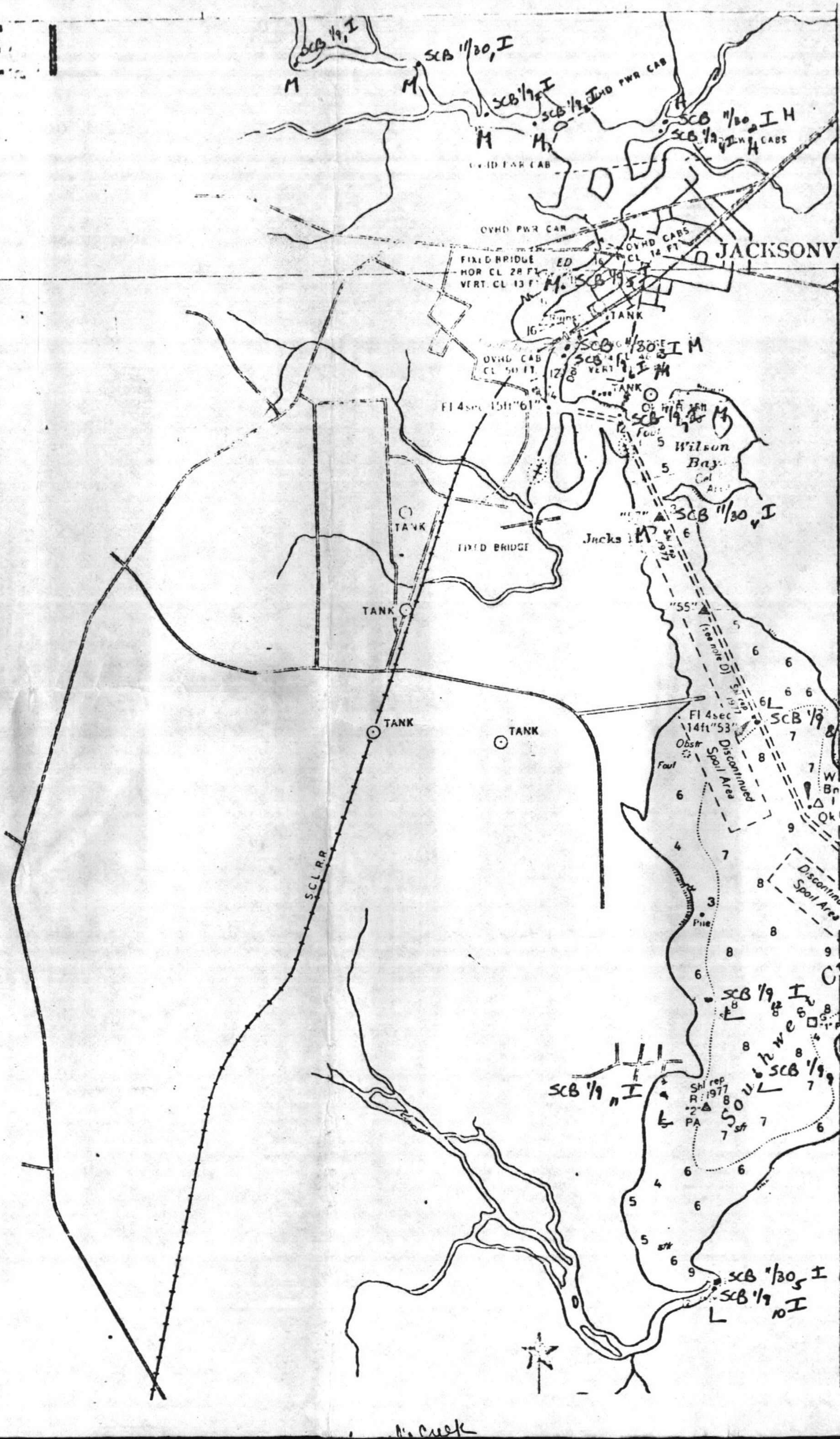
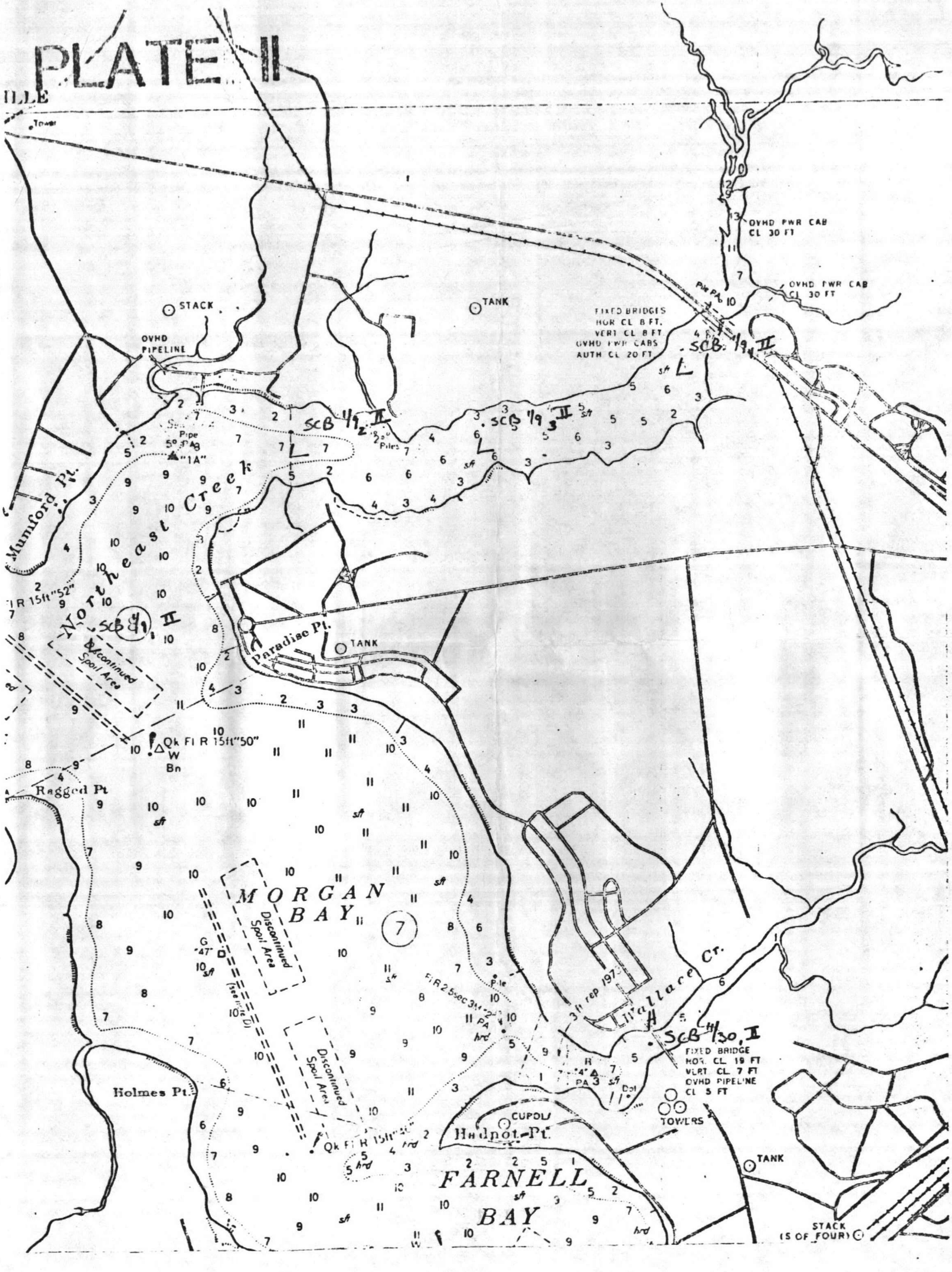

SCB 1/9, I
SCB 11/30, I
OVHD PWR CAB
SCB 11/30 I H
CABS
OVHD PWR CAB
OVHD PWR CAB
OVHD CABS CL 14 FT
JACKSONV
FIXED BRIDGE HOR CL 28 FT VERT CL 13 FT
TANK
SCB 11/30 I M
OVHD CAB CL 50 FT
TANK
Fl 4sec 15ft "61"
Foul
Wilson Bay
"57"
SCB 11/30 I
Jacks
TANK
FIXED BRIDGE
TANK
"55"
(see note D)
Fl 4sec 14ft "53"
SCB 1/9 I
TANK
TANK
Obstr
Foul
Discontinued Spoil Area
Discontinued Spoil Area
SCL RR
Pile
SCB 1/9 I
Southwest
SCB 1/9 I
SCB 1/9 I
Shl rep 1977
R "2" PA
SCB 11/30 I M
SCB 1/9 I

PLATE II



ILLE
Tower
STACK
OVHD PIPELINE
TANK
FIXED BRIDGES
HOR CL 8 FT.
VERT CL 8 FT.
OVHD PWR CABS
AUTH CL 20 FT
OVHD PWR CAB
CL 30 FT
OVHD PWR CAB
CL 30 FT
SCB 1/9 II
Pipe
"1A"
Piles
Mumford Pt.
Northeast Creek
Fl R 15ft "52"
Paradise Pt.
TANK
Discontinued Spoil Area
Qk Fl R 15ft "50"
W
Bn
Ragged Pt
MORGAN
BAY
Discontinued Spoil Area
Discontinued Spoil Area
Holmes Pt.
Wallace Cr.
SCB 1/30 II
FIXED BRIDGE
HOR. CL. 19 FT
VERT. CL. 7 FT
OVHD PIPELINE
CL 5 FT
TOWERS
CUPOLA
Hadnot Pt.
TANK
FARNELL
BAY
STACK
(S OF FOUR)

REPORT OF SANITARY SURVEY

STONES BAY AREA

AREA C-3

FEBRUARY 1980 - JUNE 1981

AUGUST 1981

AREA C-3

EXHIBIT I AREA MAP AND STATION LOCATIONS

EXHIBIT II SHORELINE SURVEY ROUTE

EXHIBIT III SEWAGE VIOLATIONS

EXHIBIT IV BACTERIOLOGICAL RESULTS AND MPN MEDIANS

EXHIBIT V PROHIBITED AREA MAP

Preface

Total Acres..15,025.

Prohibited Acres...10,165.

Oyster Production.......................................Fair To Good.

Clam Production...Fair.

Commercial Value..Fair.

Recommended Changes ....None.

REPORT OF SANITARY SURVEY

STONES BAY AREA

AREA C-3

By
SHELLFISH SANITATION PROGRAM
NORTH CAROLINA DIVISION OF HEALTH SERVICES

I. INTRODUCTION

Area C-3 is composed of all the waters of New River and its tributaries from Highway 172 Bridge at Sneads Ferry upstream to Jacksonville, N. C. (See Exhibit I for area map.) The watershed for Area C-3 consists of approximately 240 square miles and contains the Camp Lejeune Marine Base, the city of Jacksonville, and numerous communities and sub-divisions to the headwaters at Richlands, N. C. The total population in the watershed is estimated at 85,000.

There are a number of sewage treatment plants that discharge into New River, particularly in the upstream section. These plants that discharge directly into the waters of Area C-3 will be discussed in the shoreline survey section of this report.

II. SHORELINE SURVEY OF SOURCES OF POLLUTION

A comprehensive shoreline survey was begun in Area C-3 on February 25, 1981, and was completed on April 6, 1981. Conducting the survey was Mr. Ralph Johnson of the Shellfish Sanitation staff.

Prior to beginning the survey, Mr. Johnson visited the Onslow County Health Department. He explained his plans for the survey, specifically the area and the time in which he would be working. The sanitarians of Onslow County agreed to assist in the follow-up of corrections and in advising recipients of notices on corrective action.

The route followed while conducting the survey was basically the same one which was used during the last shoreline survey. The specific route can be seen in Exhibit II.

All residences, businesses, and places of public assembly along this route were visited. An inspection of the sewage disposal system at each place, at which someone was found to be present, was made. Notices of Violation were issued in cases where a malfunction was found to exist. A copy of each notice was given to the Onslow County Health Department. Exhibit III shows the nature of these violations.

Of the 287 residences, businesses, and places of public assembly found in the area, 224 inspections of sewage disposal systems were made. Of the 224 inspections that were made, 24 were found to be malfunctioning. At the time of this report, 15 corrections have been made.

Area C-3 is comprised of a significant amount of area that is owned and used by the U. S. Marine Corps (Camp Lejeune). Most of the sewage disposal in this area is achieved through the use of 2 sewage treatment plants. There are also 2 other STP's in the area. Exhibit II shows their location. The 4 STP's found in the area are as follow.

1) Dixon High School and Dixon Elementary School - The sewage disposal system serving this school facility has been upgraded since the last shoreline survey (1977). It is an aerobic package plant which offers tertiary treatment with post chlorination. Its average actual daily flow is unknown, but it is designed for 18,000 gpd. The school operates the STP and is under a self-monitoring system. It is, however, checked by the N. C. Division of Environmental Management once a year. Final outfall for the effluent is in the headwaters of Stones Creek.

2) H & J Mobile Home Park - This package treatment plant serves 43 mobile homes, a store, a laundry, and a filling station. It still offers secondary aeration with post chlorination prior to final discharge into Hicks Run Creek. According to the maintenance engineer for the mobile home park, no major changes have been made since the last shoreline survey.

3) Hadnot Point STP (U.S.M.C.) - This trickling filter system is located on Camp Lejeune. According to the Base Maintenance Officer, no major changes have occurred since 1977. According to their records, the STP has treated an average of 4,712,891 gpd during the time period of January - April, 1981. The U.S.M.C. monitors this STP daily. Discharge is made into New River north of Frenchs Creek.

4) Rifle Range STP (U.S.M.C.) - This trickling filter STP is also located on Camp Lejeune property. They discharged an average of 235,975 gpd from January - April, 1981, into New River northeast of Everett Creek. This STP is also operated and monitored daily by the U.S.M.C. According to the Base Maintenance Officer, no major changes have been made since 1977.

There is only one marina located in Area C-3. This is Old Ferry Fish Company, which is located beside the south end of the Sneads Ferry Bridge on Highway 172. The number of boats with marine heads which use these docks is unknown. Most of them are commercial trawlers and the number using the docks ranges from 0-20 at any given time. No pump-out facility is provided.

The population of Area C-3, disregarding the personnel living on Camp Lejeune, is approximately 10,500. This population is mostly permanent, but transient in nature. Most of the people living here are military personnel who live off base.

The following animals were found during the survey.

Dogs	150	Goats	5

Hogs	10	Fowl 40
Horses	2	

There was no significant amount of open dumping of trash and garbage observed. Solid waste is collected and disposed of by Onslow County and the U.S.M.C. No sanitary landfills were found in the area.

The vegetation in Area C-3 is basically that of mixed pine and hardwood forests. No source of chemical, nuclear, or radiological pollution was found.

III. EVALUATIONS OF HYDROGRAPHIC FACTORS RESPONSIBLE FOR THE SPREAD OF POLLUTION

There are a number of sewage treatment plants in this area. These have been mentioned in the shoreline survey section. Drogue studies were conducted in the River during the 1977 evaluation. There has been no change in current patterns noted during this evaluation period.

IV. BACTERIOLOGICAL, CHEMICAL, AND RADIOLOGICAL SURVEY OF SHELLFISH GROWING WATERS AS INDICATED

The bacteriological survey was begun in February, 1980, and concluded in June, 1981. During the survey 243 water samples were collected from 21 sampling stations. (See Exhibit I for station locations.) Results indicate little change in the bacteriological water quality since the last survey. Stations #23 and #24 had unsatisfactory medians of 75 and 150 respectively. Both stations are within the prohibited area boundary in Everett Creek. Station #27 exceeded the 10% rule and it is also within the prohibited area of the upper New River. All other stations are satisfactory. (See Exhibit IV for bacteriological results and MPN medians.) There were 8 shellfish samples examined during this period and all had satisfactory results.

Radiological surveillance continues in the area and results are available from the Radiological Surveillance Unit of the Division of Health Services in Raleigh. Samples are collected twice a year.

V. SUMMARY AND RESULTANT AREA CLASSIFICATION

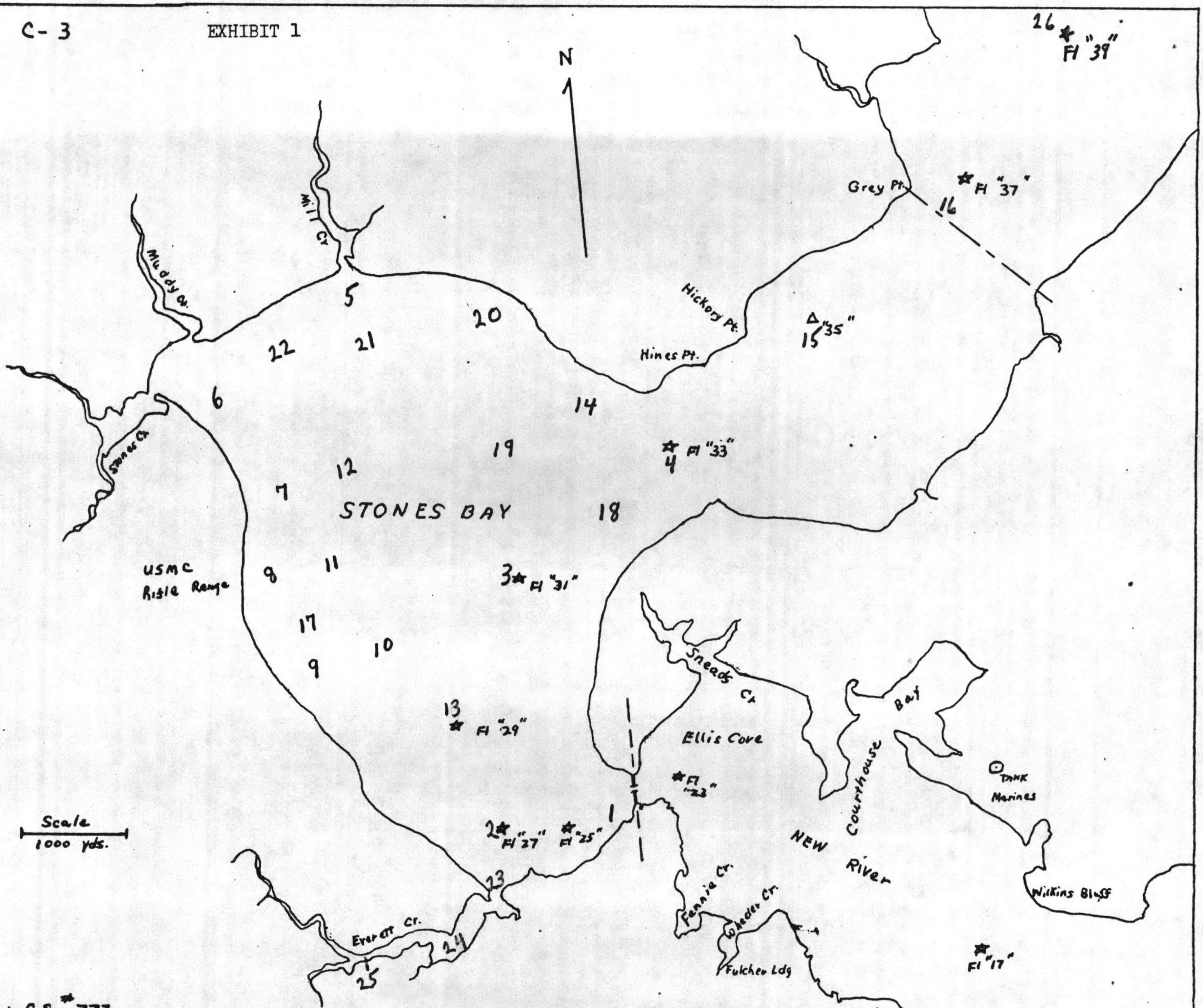
The majority of pollution sources are located in the upper portion of New River and outside of productive shellfish bottoms. There is enough dilution in the lower section of the river to eliminate any problem from upstream sources. Sewage treatment plants associated with the Camp Lejeune Marine Base appear to be operating efficiently and all have buffer zones around the outfalls.

There were 3 stations with unsatisfactory results during this survey, Stations #23, #24, and #27. Stations #23 and #24 are in the closed area at Everett Creek. Station #27 is located at Channel Marker #42 in New River. The MPN median at this station was 33, but 2 high coliform counts made it in violation of the 10% rule. There are no shellfish in this area of the river and the area is prohibited.

It is, therefore, felt that the waters of New River are properly classified and no changes are to be recommended. (See Exhibit V for prohibited area map.)

Area C- 3

EXHIBIT 1



From USC + GS # 777

EXHIBIT 11

SHORELINE SURVEY ROUTE

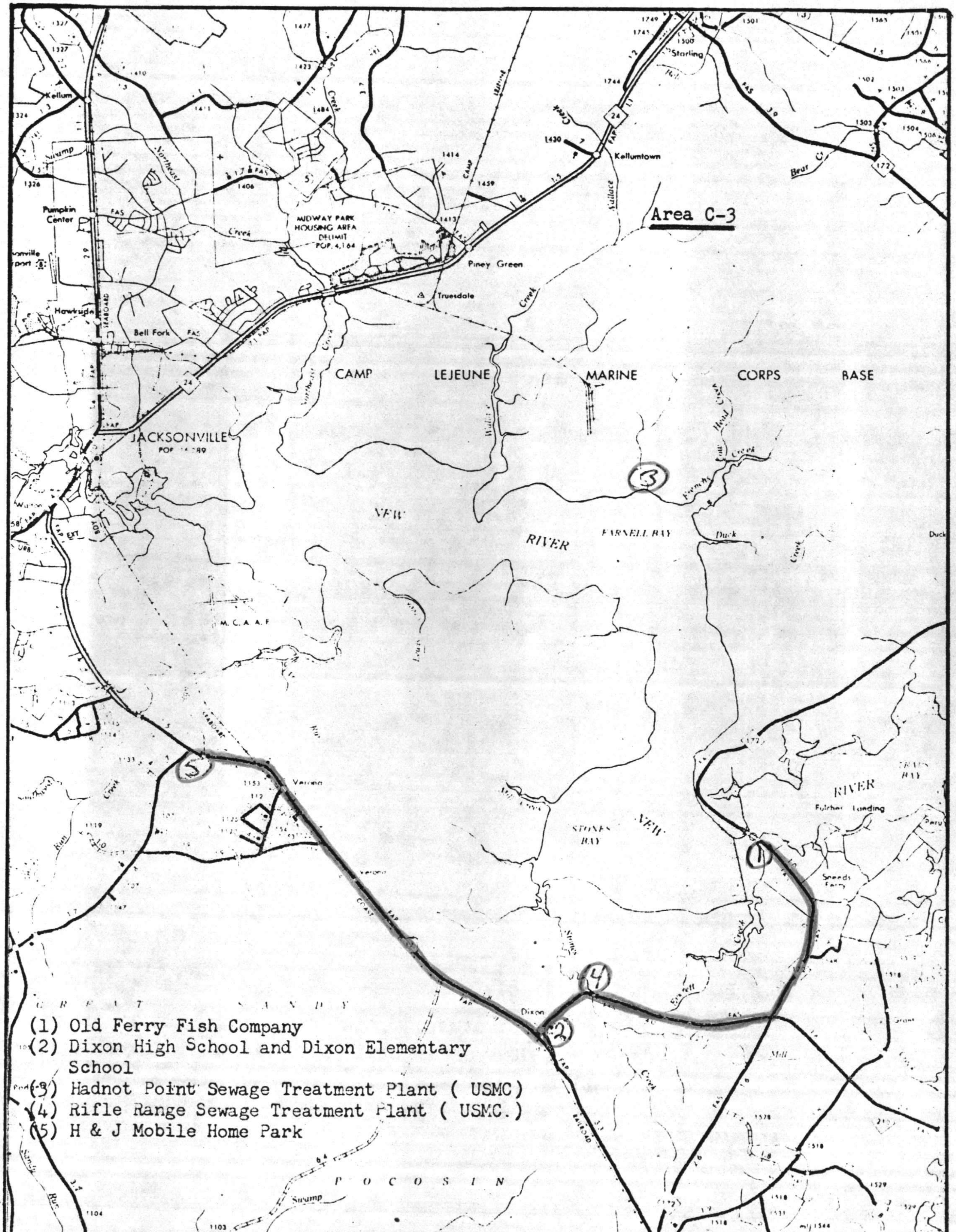


EXHIBIT 111

SHORELINE SURVEY DATA

XXXXX Area C - 3 COUNTY Onslow DATE 4-13-81

No.	XXXX Date	Owner	Tenant	Location	Violation	Date Corrected
# 1	2-25-81	Mr. Garland Rhodes		Rt.# 1 Sneads Ferry, N.C.	Washing Machine Waste to be included in system	4-23-81
# 2	2-25-81	Mr. Levi Simmons		Rt.# 1 Sneads Ferry	Repair septic tank and drainfield	4-23-81
# 3	2-25-81	Mr. L.W. ~~Jarvis~~ Jarvis	Mr. James Mathieson	Rt.# 1 Sneads Ferry, N.C.	Repair septic tank and drainfield	
# 4	2-25-81	Mr. Mark Hufnagle		Rt.# 2 Holly Ridge, N.C.	Washing Machine Waste to be included in system	4-23-81
# 5	2-25-81	Mr. William H. Simmons		Rt.# 2 Holly Ridge, N.C.	Repair septic tank, kitchen and washing waste	
# 6	2-26-81	Mr. Bill Rochell		Rt.# 2 Holly Ridge, N.C.	Washing Machine Waste to be included in system	4-23-81
# 7	2-26-81	Mrs. Shirley Ottaway	Mr. James Hamric	Rt.# 2 Holly Ridge, N.C.	Washing Machine Waste to be included in system	
# 8	2-26-81	Mr. Walter C. Leo		Rt.# 2 Holly Ridge, N.C.	Washing Machine Waste to be included in system	
# 9	2-26-81	Mr. Donald Edwards	Onslow County Ranger	N.C. Forestry Bldg. Rt.#2 Holly Ridge, N.C.	Kitchen Waste to be included in system	
# 10	3-3-81	Mr. Leroy E. Foreman		Hwy # 17 Verona, N.C.	Washing and kitchen to be included in system	4-23-81
# 11	3-3-81	Mr. Nathan Bryant		Hwy # 17 Verona, N.C.	Repair septic tank and drainfield	
# 12	3-3-81	Mr. Joseph Beasley	Mr. William Harding	Hwy # 17 Verona, N.C.	Repair septic tank and kitchen waste	4-23-81
# 13	3-3-81	Mr. Vergil Hill		Hwy # 17 Verona, N.C.	Washing Machine Waste to be included in system	
# 14	3-3-81	Mr. George Donaldson		Hwy # 17 Verona, N.C.	Washing and Kitchen waste to system	4-23-81
# 15	3-3-81	Mr. Gerald Brown	Mr. Gary Burkhalter	Hwy # 17 Verona, N.C.	Repair septic tank and drainfield	4-23-81

Total Violations ______

Ralph L. [signature]
Surveyors

Cumulative Total Corrections ______

- EXHIBIT 111

SHORELINE SURVEY DATA

XXXXX Area C - 3 COUNTY Onslow DATE 4-13-81

No.	XXXX XXXXX Date	Owner	Tenant	Location	Violation	Date Corrected
# 16	3-3-81	Mr. Gerald Brown	Mr. Rodney Anderson	Hwy # 17 Verona, N.C.	Grease trap needs to be repaired	4-23-81
# 17	3-3-81	Mr. Gerald Brown	Mr. Thomas Campbell	Hwy # 17 Verona, N.C.	Repair septic tank and drainfield	4-23-81
# 18	3-4-81	Mr. Edward XXXX Suggs		Hwy # 17 Verona, N.C.	Repair septic tank and drainfield	4-23-81
# 19	3-4-81	Mrs. Bessie Sewell	Mr. Herbert Hinton	Hwy # 17 Verona, N.C.	Repair septic tank and drainfield	4-23-81
# 20	4-6-81	Daugherty Mobile Home Park	Mr. Lawrence Hingula	Rt.# 3 Jacksonville, N.C.	Repair solid pipe to system	4-23-81
# 21	4-6-81	H & J Mobile Home Park	Mr. Robert Smith Lot # 7	Rt.# 3 Jacksonville, N.C.	Repair connection under mobile home.	4-23-81
# 22	4-6-81	H & J Mobile Home Park	Mr. Johnson lot # 37	Rt.# 3 Jacksonville, N.C.	Repair connection under mobile home	4-23-81
# 23	4-23-81	Mrs. RoseMary Higgins	Miss JoAnn Simmons	Rt.# 3 Box 119 Jacksonville, N.C. 28540	Repair drainfield to system	
# 24	4-23-81	Mr. R.E. Davis		Rt.#3 Box 126 Jacksonville, N.C. 28540	Repair drainfield to system	

Note: The last two violations (23 & 24) were written during the first follow up inspection.

Total Violations 24

Ralph L. Johnson

Surveyors

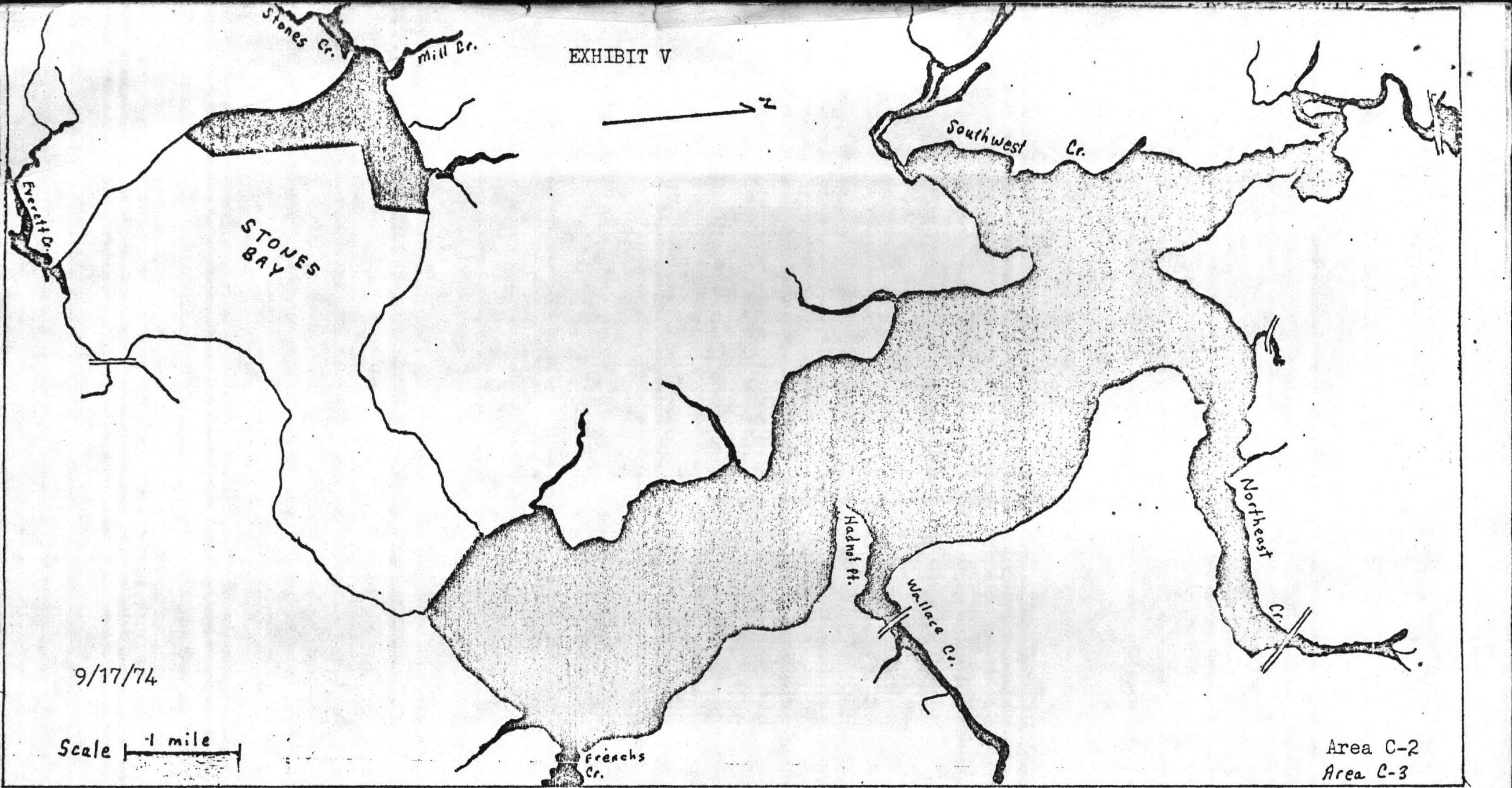
Cumulative Total Corrections

SH-1 EXHIBIT IV

AREA C-3

FECAL COLI - TOP
TOTAL COLI - BOTTOM

STATION NOS.	9/12/80	10/14/80	10/20/80	11/3/80	12/2/80	1/26/81	2/4/81	2/9/81	3/16/81	3/24/81	3/9/81	6/8/81			Medians
1															
2	<3 3.6	<3 <3	<3 3.6	<3 <3	3.6 3.6	<3 15	<3 93	3.6 43	<3 3.6	<3 <3	<3 <3	<3 <3			3.6
3	<3 23	<3 <3	<3 <3	[illegible] 7.3	[illegible] 3.6	<3 23	<3 93	3.6 240	<3 <3	3.6 3.6	<3 <3	<3 <3			3.6
4	<3 15	<3 <3	<3 7.3	<3 <3	[illegible] 23	<3 93	[illegible] 240	<3 240	<3 93	<3 9.1	<3 9.1	<3 <3			12
5	<3 3.6	<3 <3	<3 3.6	15 43	<3 <3	<3 3.6	<3 21	<3 7.3	<3 3.6	3.6 3.6	<3 9.1	240 460			3.6
5A															
6															
7															
8	<3 <3	<3 <3	3.6 3.6	3.6 9.1	<3 <3	<3 <3	3.6 23	3.6 150	<3 43	<3 15	3.6 3.6	150 >1100			6.4
9	<3 23	<3 <3	3.6 9.1	<3 <3	9.1 9.1	<3 3.6	<3 15	3.6 23	<3 43	3.6 9.1	<3 <3	1100 >1100			9.1
10	3.6 9.1	<3 <3	<3 <3	<3 3.6	<3 <3	<3 <3	<3 7.3	<3 93	<3 21	<3 3.6	<3 3.6	>1100 >1100			3.6
11	<3 <3	<3 <3	3.6 3.6	<3 3.6	<3 3.6	<3 3.6	<3 15	9.1 29	<3 3.6	<3 3.6	<3 <3	3.6 23			3.6
12	9.1 93	<3 <3	<3 <3	<3 <3	9.1 9.1	<3 21	<3 9.1	<3 43	<3 3.6	23 43	<3 3.6	<3 3.6			6.4
13															
14	3.6 9.1	<3 <3	<3 3.6	15 15	3.6 3.6	<3 93	3.6 93	<3 43	<3 93	3.6 3.6	<3 3.6	<3 <3			6.4
15	<3 23	<3 <3	3 3	9.1 9.1	9.1 9.1	<3 43	9.1 43	3.6 93	<3 460	3.6 9.1	<3 9.1	<3 7.3			9.1
16	7.3 15	<3 <3	<3 <3	3.6 23	<3 <3	<3 93	3 43	9.1 240	3.6 1100	3.6 9.1	<3 <3	<3 11			13.0
17	<3 9.1	<3 <3	3.6 3.6	<3 3.6	<3 3.6	<3 3.6	[illegible] 43	<3 15	3.6 9.1	3.6 9.1	<3 15	460 1100			9.1
18															
19															
20	3.6 9.1	<3 <3	<3 <3	<3 <3	<3 <3	<3 3.6	<3 43	<3 93	<3 3.6	<3 7.3	<3 <3	<3 9.1			3.6
21															
22															
23	<3 7.3	3.6 3.6	43 240	23 75	3.6 3.6	3.6 23	[illegible] 240	<3 93	<3 93	<3 240	<3 9.1	<3 9.1			75
24	93 >1100	[illegible] 23	460 460					3 460	<3 43	23 93	39 150				150
25															
26	<3 7.3	<3 3.6	<3 <3	<3 9.1	9.1 9.1	<3 43	15 93	3.6 43	3 460	9.1 15	9.1 23	<3 9.1			12
27	3.6 23	<3 <3	43 240	<3 15	9.1 15	<3 93	3.6 43	[illegible] 460	<3 1100	9.1 23	<3 93	<3 23			33
28															
29															
30	<3 15	<3 <3	9.1 43	7.3 7.3	14 39	<3 240	3 43	9.1 460	3.6 43	3.6 43	<3 9.1	3 240			43
31															
32															
33															
34	<3 7.2	<3 <3	9.1 9.1	<3 <3	<3 15	<3 9.1	3.6 93	9.1 240	<3 9.1	23 23	<3 <3	9.1 75			9.1
35															
23A	<3 43	<3 23	[illegible] 43	<3 3.6	14 39		[illegible] 43	3.6 93				3.6 3.6			41



23) In New River Area:

No person shall take or attempt to take, any oysters or clams or possess, sell, or offer for sale, any oysters or clams taken from the following polluted areas:

d) In Stones Bay:

Beginning at a point 34° 35' 16" N, 77° 26' 07" W; thence 45° M, 700 yards in Stones Bay, to a point 34° 35' 32" N, 77° 25' 52" W; thence 1° M, 2340 yards to a point 34° 36' 42" N, 77° 25' 58" W, in Stones Bay; thence 80° M, 1030 yards, 34° 36' 49" N, 77° 25' 23" W, in Stones Bay; thence 11° M, 800 yards to a point 34° 37' 12" N, 77° 25' 20" W, on the shore.

e) In New River:

In all of the waters of New River and its tributaries, upstream from a line drawn 133° M, from a point on the west shore of New River, 34° 37' 36" N, 77° 22' 21" W, to a point on the east shore, New River, 34° 37' 09" N, 77° 21' 38" W.

c) In Everett Creek:

In Everett Creek and its tributaries, south and west of a line drawn from a point on the west shore, 34° 34' 18" N, 77° 24' 55" W; thence 94° M, 550 yards to a point on the east shore, 34° 34' 18" N, 77° 24' 35" W.

Review Comments on the Bacteriological Analysis of the New River Estuary Report

There is a general consensus that this draft of the New River Study is more clearly written and organized, with a number of substantial improvements made over the February draft. The figures and tables are more clearly labelled. The statistical analysis, confusing in the previous draft, has been omitted. The literature review is a useful addition, although it could be better organized. However, there are still several points from the March 3 comments which were not addressed.

1. As stated in the March 3rd comments, the following funding acknowledgement should appear in the acknowledgement section in the front of the document:

   > The preparation of this report was financed by the North Carolina Coastal Management Program, through funds provided by the Coastal Zone Management Act of 1972, as amended, which is administered by the Office of Coastal Zone Management, National Oceanic and Atmospheric Administration.

   The funding information on page 2 is not complete.

2. As stated in the March 3rd comments, the figures and tables should be listed in the Table of Contents.

3. As stated in the March 3rd comments, there needs to be some reference between the numbers on the maps and the tables.

4. As stated in the March 3rd comments, please define the legal limits of SA Waters as compared with the desired limits.

5. The report still does not explain the difference between single and double lauryl tryptose methodologies. At first, Ms. Roznowski used double strength lauryl tryptose in fecal coliform presumptive testing. She later switched to single strength lauryl tryptose. One would expect double strength to give a lower MPN (most probable number) than single strength. By running 10 simultaneous samples with both methods, she can explain if there is a significant difference between the data using the different methods. To only be acknowledging that she switched lab methods during the project does not make it possible to draw any valid conclusions from the data set. It is also necessary to state at which date she changed methods because the data from the first method cannot be compared to any other research. This explanation is necessary to ensure the integrity of the report, and the comparison of the data from the two methods is essential to interpretation of any trends. These corrections were asked for initially in June, 1981 and again in February, 1982.

6. There are still some improvements that could be made to make the document more usable by planners and elected officials. These include:

   a. A more detailed base map which includes the locations of place names discussed in the text including; Wilson Bay, Camp LeJeune, Dixon, Southwest Creek, Wallace Creek and Frenches Creek;

   b. A map showing point source discharges;

   c. A general land use map;

d. A map showing areas with dominantly human fecal streptococci/ Pseudomonas sp. versus animal sources if possible;

e. A map of closed shellfish waters;

In addition, a more detailed sample station map would be necessary for any future studies which might build on the present one. Sample stations should be marked on the map, preferably with latitude and longitude or state plane coordinates listed if possible. A number of sample stations are not even located near a water body according to the maps provided.

7. As stated in the March 3rd comments, the report needs to note where the septic tanks are failing.

North Carolina Department of Natural Resources & Community Development
James B. Hunt, Jr., Governor
Joseph W. Grimsley, Secretary

OFFICE OF COASTAL MANAGEMENT
Kenneth D. Stewart
Director
Telephone 919/733-2293

June 8, 1982

Mr. Ken Windley, Planning Director
107 New Bridge Street
Jacksonville, NC 28540

Dear Ken:

Our staff has completed the review of the Bacteriological Analysis of the New River Estuary Report which the county has undertaken through contract number 9787 with the N. C. Department of Natural Resources and Community Development, Office of Coastal Management. The review comments are attached for your consideration. Since there is frequent reference in our comments to our previous comments of March 3, 1982, I am also attaching a copy of these.

I would like to hold off on the usually scheduled administrative close-out of this contract until these final comments are addressed to the county's and state's satisfaction. I do not foresee that this will take any great length of time since the major concerns of the March 3 comments have been addressed.

However, there are funds available in the contract budget for a partial requisition if you so desire. Please contact me if you should wish to draw upon these funds.

If you should have any questions, please give me a call at 733-2293.

Sincerely,

Gaile Pittman

Gaile Pittman
Coastal Land Use Planner

GP/aw

cc: Horace Mann, Jacksonville City Planner
Susan Schmidt
Steve Benton
Danny Silvers
R. G. Leary, County Manager

P. O. Box 27687 Raleigh, N. C. 27611-7687